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OF
Western Australia.

Vol. XVII.
1930-31.



The Authors of Papers are alone responsible for the statements
and
the opinions expressed therein.

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—
1931.

THE ROYAL SOCIETY OF WESTERN AUSTRALIA.

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**ANNUAL REPORT OF THE COUNCIL
FOR
YEAR ENDING 30th JUNE, 1931.**

LADIES AND GENTLEMEN,

Your Council begs to submit the following report for the year ending 30th June, 1931.

MEMBERSHIP.

There are 207 members on the roll, of whom 10 are honorary members, six corresponding members, 118 ordinary members, 63 associate members, and 10 student members. During the year five ordinary members and 10 associate members have been elected and three associates have transferred to ordinary membership and five student members have become associates. 13 ordinary members and seven associate members have resigned. The names of six ordinary members and four associates have been removed in accordance with Rule 13.

The Society has lost, by death, three of its most valued members. Mr. F. E. Allum, I.S.O., was a foundation member and had filled the offices of President, Treasurer, and Editor, and was a Councillor of the Society from its formation until his death.

Mr. W. Catton Grasby took an active part in the foundation of the Society, and for many years filled the office of Secretary. He was President during the 1929-30 session.

Sir Robert McMillan, the late Chief Justice of the State, was also a foundation member, and in the early stages of the Society's history took a keen interest in its proceedings.

COUNCIL.

Nine ordinary meetings of the Council were held during the year.

Mr. H. A. Pittman and Mr. D. L. Serventy were co-opted to the Council to fill the vacancies caused by the deaths of Messrs. Allum and Grasby.

In May Dr. Teakle found it necessary to relinquish the office of Treasurer owing to his official duties causing him to be absent from Perth for some time. Mr. Pittman has taken over the duties of Treasurer and finalised the accounts and balance-sheet, and prepared the books for audit. Messrs. R. E. Gatherer and G. Spencer Compton were appointed auditors by the Council.

FINANCE.

The statement of the Society's income and expenditure during the 1930-31 session, which will be the subject of a separate report, may be summarised as follows:—

During the year the total receipts on account of income, which includes the subsidy granted by the Government, amounted to £276 4s. 1d., being £10 1s. 3d. less than that received during the previous session. The current expenditure of the Society's year amounted to £377 14s. 11d.

The excess of expenditure over receipts for the year amounted to £101 10s. 10d.

The grant received from the Treasury during the year was at the rate of £100 per annum, as in preceding years, and the Council wishes to express its thanks to the Government for the subsidy. Without the aid of the Government grant the publication of papers in the Journal would have to be seriously curtailed.

PUBLICATIONS.

Volume XVI., containing the proceedings and transactions for the year 1929-30, has been completed and issued to members, and distributed in accordance with the exchange list.

Volume XVII., containing the proceedings for the year 1930-31, is well in hand. All papers contributed to the Society have been printed and reprints issued to authors. The volume should be completed and issued to members early in the forthcoming session.

Mr. B. L. Southern has carried out the onerous duties of Editor in a manner which has earned the appreciation of authors and the thanks of the Council.

The large number of papers coming forward and the limited resources of the Society have given the Council considerable concern. This year the Society has spent the sum of £309 9s. 4d. in printing, which is in excess of the Society's revenue. The position has been met this year by foregoing the annual conversazione of the Society, and by asking authors to contribute towards the cost of reproduction of plates and figures. £35 has been donated to the Society in this way, including £10 from the Department of Geology, University of Western Australia.

It will be necessary for the incoming Council to consider the best means of continuing to afford Western Australian workers reasonable facilities for the publication of original contributions to science and, at the same time, conserve the financial position of the Society.

L. W. PHILLIPS,

C. A. GARDNER,

Joint Hon. Secretaries.

[illegible]

Examined and found correct.

H. A. PITTMAN,
Hon. Treasurer.

ABSTRACT OF PROCEEDINGS, 1930-31.

8TH JULY, 1930—

Annual General Meeting. Election of Officers. Report by Delegates—
Professors Wilsmore and Clarke—on Brisbane Meeting A.A.A.S.

12TH AUGUST, 1930—

Paper—"The Language of Worrora," Rev. J. R. B. Love.

Lecture—"The Evolution of Chitons," Mr. E. Ashby.

9TH SEPTEMBER, 1930—

Lecture—"Pleistocene Skulls and Their Anthropological Significance,"
Dr. E. J. T. Thompson.

Lecture—"Australian Aborigines," Dr. D. S. Davidson.

Lecturette—"The Flora of the Nullabor Plain," Miss E. R. L. Reed.

14TH OCTOBER, 1930—

Lecture—"Chemical Research and the State," Prof. N. T. M. Wilsmore.

Paper—"The Eggs of the Banded Stilt" (*Cladochyneus leucocephalus*),
Mr. L. Glauert.

11TH NOVEMBER, 1930—

Paper—"Fossils from the Wooramel District, W.A.," Miss L. Hosking.

Paper—"The Oligochaete of South-Western Australia," Miss Ada Jackson.

10TH MARCH, 1931—

Lecturette—"The Fluctuations of Apple Crops," Mr. W. M. Carne.

Lecture—"The Braxy-like Disease," Mr. W. H. Bennetts.

10TH APRIL, 1931—

Lecture—"The Denmark Disease," Mr. J. F. Filmer.

Address—"The Natural History of Rottnest Island," Mr. L. Glauert.

12TH MAY, 1931—

Paper—"Contributions to the Mineralogy of Western Australia," Series
VI., Dr. E. S. Simpson.

Paper—"The Occurrence of Rubidium, Caesium, and Thallium in some
Western Australia Micas," Mr. D. G. Murray and Mr. F. E. Chapman.

Paper—"Bees in the Collections of the Western Australian Museum and
the Department of Agriculture, Perth," Tarlton Rayment (com-
municated by Mr. L. Glauert).

9TH JUNE, 1931—

Lecture—"Photographic Technique," Mr. A. Knapp.

Exhibits—*Ranina dentata*, Mr. L. Glauert. *Strelitzia reginae* and *Crotalaria laburnifolia*.

EXCURSION TO BULLSBROOK.

Several items of interest were discovered during this well attended excursion on 16th May. Dr. Simpson addressed members regarding the Bullsbrook marl, while the Misses Carroll, Prendergast, and Bowley, who, with Miss Hosking, have been mapping the district, supplied detailed information on the fossils, etc. Copies of a progress map were made available.

1. *Metamorphic Rocks*.—It was surprising to find that well banded gneisses, etc., form the country on the east side of the area traversed. This is in strong contrast to the massive granite which forms the bulk of the "Range" from Darlington to Upper Swan.

2. *Leaf Bed and Associated Strata*.—The leaf bed was found by this excursion at the head of the south branch of the Ki-it-monger Brook. This is three-quarters of a mile east of the previously known outcrops.

3. *Physiography*.—The area is excellent for the study of river development. Within a square mile are miniature examples of all types of valley from very old to very young, of impending river capture and of rejuvenation—including a miniature canyon.

E. de C. CLARKE,

J. E. WELLS,

Co-leaders.



JOURNAL OF THE ROYAL SOCIETY OF WESTERN AUSTRALIA.

Vol. XVII.

I.—CONTRIBUTIONS TO THE FAUNA OF ROTTNEST ISLAND.

No. VII.

NOTES ON THE BANDED STILT (*CLADORHYNCHUS LEUCOCEPHALUS*), WITH A DESCRIPTION OF ITS EGGS.

By L. GLAUERT, B.A., F.G.S., and C. F. H. JENKINS, R.A.O.U.,
with two plates.

By permission of the Trustees of the W.A. Museum.

Read 14th October, 1930. Published 15th January, 1931.

Descriptions of the nest and eggs of the Banded Stilt, or Rottneist Snipe *Cladorhynchus leucocephalus* (Vieillot), have appeared from time to time during the last fifty years, but one and all have subsequently been questioned or rejected because of inaccurate data. In 1913 the late A. J. North was compelled to admit "I have not seen a properly authenticated set of its eggs," and as far as we are aware these words sum up the position at the present time.

E. P. Ramsay's description of 1883¹ was rejected by A. J. North² because the eggs were found to be those of the White-headed Stilt, *Himantopus leucocephalus*, and A. J. Campbell's specimens³ collected by Lindsay Clark near Booligal on the Lachlan River, New South Wales, probably belong to the same species, for the collector, who also sent an egg to the Australian Museum, Sydney, wrote to North at a later date stating that "he had incorrectly identified the bird, and the egg belonged to the White-headed Stilt."⁴

The eggs ascribed to the Banded Stilt in the "Catalogue of the Jackson Oological collection," Sydney, 1907, most certainly do not belong to this species; they are much too small and their coloration is too dark.

In his "Birds of Australia"⁵ Gregory M. Mathews merely quoted from Ramsay, who, as we have seen, described eggs of the White-headed Stilt, and there seems little doubt that a similar mistake was made by Mathews and Iredale in 1921⁶: The descriptions of the eggs of the White-headed Stilt on page 154, and of the Banded Stilt on page 155, showing striking resemblances both in coloration and size.

1 Proc. Lin. Soc. New South Wales, VII., 1883, p. 57.

2 Nests and eggs of Birds found breeding in Aust. IV., part 3, Oct., 1913, p. 293.

3 Report of the A.A.A.S., V. Adelaide, 1893 (1894), p. 439.

4 North loc. cit.

5 Vol. III., part 2, p. 155—April, 1913.

6 A Manual of the Birds of Australia, vol. I., 1921, p. 155.

For some years one of us (L.G.) has been interested in the nesting habits of the Banded Stilt ; that a bird well known to all who visit Rottnest Island in the summer time, should keep its secret so successfully appeared worthy of investigation. It seemed unlikely that the breeding places were outside Australia, and yet information concerning the "winter migration" was of the vaguest possible character. Now and again visitors to the Museum stated they had seen the Rottnest Snipe on this or that salt lake in the interior, but never were they able to submit evidence in confirmation.

In August, 1929, a letter was received from Mr. F. A. Schoch, Head Teacher of the Kurrawang State School, asking for the name of a bird locally known as the "snipe" ; it was "13½ inches long. Head, neck, back, breast pure white ; wings black, barred lightly white ; bill black 2in. long, web-footed." The bird had been brought to the school by one of the children and was a stranger ; it seemed without doubt that this was an immature Banded Stilt, and so a request was forwarded for eggs, but without result. This year Mr. Schoch visited the lakes where the birds had been plentiful the previous winter, and as he has not reported upon the trip it is assumed that the birds were not present.

Last March Mr. T. Smith, of Kalgoorlie, asked for "comments on the migration of young 'Rottnest Snipe' which took place from a large lake some distance from Menzies this spring ; almost as soon as they were hatched they started to walk to the coast. I doubt if any reached there. I would be quite safe in saying they must have died by the hundred thousand, for a strip of country about 30 miles wide was literally white with the dead birds ; they were all in good condition and there was water in the lake they came from."

When asked for a description of the adult birds Mr. Smith wrote, "they were mainly white, faint brown band on the breast, wings black, part of the belly black, bill black, legs inclined to dirty white, feet webbed." No further news having been received from Mr. Smith, it is assumed that the birds were not noticed near Menzies this winter. It would seem, therefore, that last year the birds nested in the Menzies district, about 80 miles North of Kalgoorlie and Kurrawang, between Kalgoorlie and Coolgardie, and that they failed to return this year. At the latter locality they seem to have reared their young successfully, whilst at the former the young birds "died by the hundred thousand."

On August 4th last Mrs. B. E. Cannon, of Kukerin, forwarded a blown egg to the Museum, and in a letter enclosing three photographs asked for the name of the birds, stating "we found thousands of them on a sandy spit running out into Lake Grace. The birds have a sharp black beak, long pink legs and webbed feet ; they are black and white. This last week they have been hatching out—the chicks are white like eiderdown, with black legs and beak. On Tuesday night (July 29th) we heard many of the birds going overhead high up, and yesterday (Sunday, August 3rd) the nests were deserted, holes picked into the remaining eggs, and the chickens picked out."

A request for further material was most generously acceded to by Mr. and Mrs. Cannon, and on September 4th a consignment of no less than 23 unblown eggs was forwarded, one of them containing a dead chick about ready for hatching. As a result of this help the Museum now possesses 19 eggs and a chick.⁷

7 At a later date Mr. W. Broadwith, of Kukerin, who visited the Lake with Mr. and Mrs. Cannon, forwarded two adult birds in full plumage, one immature bird, and one chick (nestling in down).

The eggs show considerable variation in size, shape, coloration, and markings. The length ranges from 65 mm. to 51.75 mm., and the width from 40 to 36, the average being about 55 x 38.5 mm. The shape varies from pyriform to long oval, while the ground colour shades from dull white to cartridge buff, and the markings may take the form of heavy blotches and smaller spots or irregular lines and scribblings of blackish-brown interspersed with lines and spots of slate-grey appearing as if beneath the surface. The texture of the shell is fine, and fresh eggs would seem to possess a slight gloss.

Description of the type eggs.

A 3704. 54.25 mm. by 37.75 mm. (Plate I. fig. 1). Ground colour cartridge buff, heavily blotched with blackish-brown (3), with scattered spots of slate-grey appearing as if beneath the surface. The dark blotches unite to form large irregular patches near the broader end. Texture fine, slight gloss, pyriform.

A 3694. 54 mm. by 38 mm. (Plate I. fig. 3). Ground colour cartridge buff, with irregular lines and scribblings of blackish-brown. A faint zone of irregular slate-grey lines encircles the broader end, while irregular slate markings are scattered over the surface. Oval inclined to pyriform.

A. 3687. 53 mm. by 39 mm. (Plate I. fig. 2). Ground colour dull white, with irregular black and blackish-brown lines, more plentiful at the broader end; a few scattered spots of slate-grey appear as if beneath the surface. Swollen oval.

A 3691. 65 mm. by 36.25 mm. (Plate I. fig. 4). Dull white, with irregular lines of blackish-brown and faint slate-grey forming network over the surface. Long oval.

The Nests.

The nesting site and nests (Plate II. figs. 1 and 2) are described in a letter received from Mr. W. Broadwith, of Kukerin. "The birds have made no attempt to hide their eggs; there are some bushes on the neck of the spit and tufts of grass around the edge of the part of the spit where the birds have made their nests, but the rest of the ground is bare, the eggs being laid in small saucer-shaped depressions on the bare ground. There are not less than three eggs to a nest and not more than four. The nests are very close together—I should say at least one to the square foot. The site of the nesting ground is nearly an acre in extent."

The Nestlings.

The nestling from the egg (A 3710) measures approximately 85 mm. It is covered with whitish down black at the base, about 20 mm. long on the body, the head and neck are almost bare, the scanty down present on these parts being much shorter. The bill is slender, pointed and straight, and the feet are webbed as in the adult birds; both legs and bill are greyish (in spirit).

Measurements: Bill 12.5 mm.; tarsus 25; middle toe and nail 14,

The larger nestling (A 3716) found dead on the ground, differs but slightly from the nestling from the egg ; the bill is longer and slightly recurved, and both it and the legs are blackish, the webbing being slightly paler.

Measurements : Bill 22 : tarsus 37 ; middle toe and nail 21·5.

Remarks.

At Lake King, ninety miles East of Kukerin, the Banded Stilt was seen by Mr. E. Corboy, M.L.A., and Mr. H. S. Day, the latter writing : "These Snipe have been plentiful here at Lake King and district this winter. On Lake King, which is 22 miles long and has up to 2ft. of water in the winter time, the birds have been in tens of thousands and have reared countless chickens."

"The Snipe were not here last winter, which was a dry one, whilst this one has been very wet. Might an old bushman suggest to you that the 'Snipe' yearly select the wettest portions of the W.A. lake country for their migrations."

The type, eggs and nestlings, are in the collections of the Western Australian Museum.

Plate I.

Fig. 1.

Fig. 2.



Fig 3.

Fig 4.

Plate II.



Fig. 1.



Fig. 2.

II.—FOSSILS FROM THE WOORAMEL DISTRICT, WESTERN AUSTRALIA.*

BY LUCY F. V. HOSKING, B.A.

(*Read 11th November, 1930; Published 7th May, 1931.*)

I.—INTRODUCTION.

The fossils described in the following pages were collected by Messrs. H. W. B. Talbot and F. R. Feldtmann in March, 1929, while engaged in geological reconnaissance in the Wooramel District. At the request of Mr. T. Blatchford, Government Geologist, I undertook the identification of the fossils. As these include several forms new to Western Australia as well as several apparently new species, three of which mark a definite horizon hitherto unrecognised in the Western Australian Permo-Carboniferous, the material seems of sufficient interest to be published.

Where the collection contained only one specimen of a new species, I have supplemented the notes on the species by referring to additional specimens from a collection made by Mr. R. A. Hobson.

I am indebted to Mr. Blatchford for the opportunity of examining the fossils in the collection of the Geological Survey, and to Colonel Nicholson of the Wooramel Oil Syndicate for making available extra material from Mr. R. A. Hobson's collection. I have also to thank Professor E. de C. Clarke for his constant advice and help. The photographs were taken by Mr. H. G. Smith, of the Department of Geology in the University of Western Australia, whose efforts were untiring in obtaining the best possible results from difficult subjects.

* Part of the cost of publication of this paper has been borne by the Department of Geology in the University of Western Australia.

II.—LOCALITY, AGE AND FOSSILIFEROUS HORIZONS.

The fossils were collected within a fifteen mile radius from Callytharra Springs (lat. 25° 52' S., long. 115° 30' E.) on the Wooramel River. Details of the localities are not given in the text but are tabulated below.

Locality Numbers	...	...	...	...	1	1a	2	3	4	5*	6	7	8	8a
					Two miles E.S.E. of Survey Station R20.	On Wooramel River, two miles almost East of Survey Station R20.	Bed and Bank of Wooramel River, three miles above R20.	Creek ½-mile West of Callytharra Springs.	S. bank of Wooramel, ¼-mile above Callytharra Springs.	1 mile from S. bank of Wooramel, 1 mile above Callytharra Springs.	South bank of Wooramel, below Callytharra Springs.	South bank of Wooramel, 1 mile above Callytharra Springs.	Bogadi Outcamp, 7 miles South of Survey Station R18.	Ferruginous ridge near telephone line, ½-mile from Bogadi Outcamp.
COELENTERATA—														
ACTINOZOA :														
<i>Clisiophyllum talboti</i> , n. sp.	...	...	...	...	...	...	...	×	...	...	×	...	...	...
<i>Plerophyllum australe</i> , Hinde.	...	...	...	...	...	...	...	×	...	...	×	...	...	...
ECHINODERMATA—														
CRINOIDEA :														
Crinoid stems	...	...	...	...	...	...	...	×	×	×	×	...	...	...
„ plate.	...	...	...	...	...	...	...	×	...	...	...	...	...	...
ECHINOIDEA :														
Echinoid plate.	...	...	...	...	...	...	...	...	...	×	...	...	...	...
POLYZOA —														
<i>Aetomacladia ambrosoides</i> , Bretnall	...	...	...	...	...	...	...	×	...	×	×	...	...	...
? <i>Coscium</i> ...	...	...	...	...	...	...	...	×	...	...	...	...	...	...
<i>Fenestella afflaensa</i> , Bret.	...	...	...	...	...	...	...	...	×	×	×	...	...	...
„ <i>fossula</i> , Lonsd.	...	...	...	...	...	...	...	×	×	×	×	...	...	...
„ <i>horlogia</i> , Bret.	...	...	...	...	...	...	...	×	...	×	×	...	...	...
<i>Rhombopora mammillata</i> , Bret.	...	...	...	...	...	...	...	...	...	×	×	...	...	...
„ <i>multigranulata</i> , Bret.	...	...	...	...	...	...	...	...	...	×	×	...	...	...
<i>Streblotrypa marmionensis</i> , Eth. jun.	...	...	...	...	...	...	...	...	...	×	×	...	...	...
<i>Sulcoretopora meridianus</i> , Eth. jun.	...	...	...	...	...	...	...	×	...	...	×	...	...	...
BRACHIOPODA—														
<i>Aulosteges ingens</i> , n. sp.	...	...	...	...	...	×	×	...	...	...	...	...	...	...
<i>Aulosteges spinosus</i> , n. sp.	...	...	...	...	...	...	...	×	...	...	×	...	...	...
<i>Chonetes pratti</i> , Dav.	...	...	...	...	...	...	...	×	×	...	×	...	...	...
<i>Cleiothyris macleayana</i> , Eth. jun.	...	...	...	...	...	...	...	×	×	×	×	...	...	...
<i>Dielasma</i> , sp. ...	...	...	...	...	...	...	...	×	...	...	...	...	...	...
<i>Dielasma cymbaeformis</i> , Morris	...	...	...	...	×	...	...	...	...	...	...	...	...	...
<i>Productus undatus</i> , DeFrance	...	...	...	...	...	...	...	...	×	×	...	×	...	...
„ <i>semireticulatus</i> , Martin	...	...	...	...	...	...	...	×	×	...	...	×	...	...
„ <i>subquadratus</i> , Morris	...	...	...	...	...	...	...	×	...	...	...	...	...	...
„ <i>tenuistriatus</i> var. <i>foordi</i> , Eth. jun.	...	...	...	...	...	...	...	×	×	...	×	×	...	...
<i>Reticularia lineata</i> , Martin	...	...	...	...	...	...	...	×	×	...	...	...	...	...
* <i>Spirifer byroensis</i> , Glauert	...	...	...	...	...	...	...	...	...	...	...	...	×	...
<i>Spirifer hardmani</i> , Foord	...	...	...	...	...	...	...	×	...	...	...	...	...	...
„ <i>musakheyensis</i> var. <i>australis</i> , Foord	...	...	...	...	...	...	...	×	...	...	×	...	...	...
<i>Spirifer rosalinus</i> , n. sp.	...	...	...	...	×	×	×	...	...	...	...	...	×	...
<i>Spiriferella australasica</i> , Eth. jun.	...	...	...	...	...	...	...	×	×	...	×	×	...	...
<i>Strophalosia</i> , sp.	...	...	...	...	...	...	...	...	×	...	...	...	...	...
MOLLUSCA—														
LAMELLIBRANCHIATA :														
<i>Cardiomorpha blatchfordi</i> , n. sp.	...	...	...	×	×	×	...	...	...	...	...	...	×	×
<i>Cardiomorpha</i> , n. sp. ?	...	...	...	...	...	...	...	...	...	...	×	...	...	...
<i>Deltopecten subquiquelineatus</i> , McCoy, var. <i>comptus</i> , Dana	...	...	...	...	×	×	×	...	...	×	...	...	×	×
<i>Parallelodon</i> , sp.	...	...	...	...	...	...	...	...	...	...	×	...	...	...
GASTROPODA :														
<i>Ptychomphalina maitlandi</i> , Eth. jun.	...	×	×	×	×	×	...	...	...	...	...	...	?	...
PTEROPODA :														
<i>Conularia</i> cf. <i>C. warthi</i> , Waagen.	...	×	...	...	×	...	...	...	...	...	...	...	×	...

* According to Mr. Talbot these specimens were wrongly labelled, as no fossils were collected at this spot.

From this table it is seen that there is a strong resemblance between the faunas of localities 1, 1a, 2, 8 and 8a. These are characterised by the presence of abundant specimens of *Deltopecten subquiquelineatus* McCoy var. *comptus* Dana* and *Spirifer rosalinus* Hosking. At localities 1, 1a and 2 the enclosing rock is a buff-coloured sandy shale of fine sandstone, whereas at 8 and 8a the fossils are limonitic casts and replacements, apparently derived from a ferruginous sandstone, probably a local variation of the rocks found at localities 1, 1a and 2.

Localities 3, 4 and 7 show the same association of fossils as found in the Fossil Cliff beds† on the Irwin River (lat. 28° 25', long 115° 15').

The beds at locality 6, although they carry numbers of fossils common in the Irwin River beds, contain great numbers of bryozoa, which, excepting *Fenestella*, have not been recorded from the Irwin River beds, but which are identical with those described by R. W. Bretnall (G.S.W.A., Bull. 88) from the Gascoyne River District, Mt. Marmion and Wyndham River.

There are, therefore, two, or perhaps three fossiliferous horizons in the area :—

- (a) The *Deltopecten* Horizon represented by columns 1, 2 and 8.
- (b) The "Irwin" Horizon represented by columns 3, 4 and 7—correlated with the Fossil Cliff beds, Irwin River and possibly
- (c) Represented by column 6 characterised by the abundance of bryozoa.

From field evidence supplied by Mr. Hobson, the beds at locality 2 are above those of locality 3, so that the *Deltopecten* horizon is higher than the Irwin horizon. Mr. Talbot considers it likely that the bryozoan rock from locality 6 does represent a horizon distinct from that of the "Irwin horizon" of the Wooramel and if so is possibly above it.

The age of the beds further than that they are Carboniferous or Permian-Carboniferous, cannot be determined simply by correlation of the fossils with related species from other parts of the world. *Deltopecten comptus* which I have united with *Deltopecten subquiquelineatus*, is found in the Upper Marine of New South Wales; *Spirifer nitiensis* allied to *S. rosalinus*, var. *auritus* is found in the Permian of the Salt Range and Spiti; *Conularia warthi* is found in the Permian of the Salt Range. On Schuchert's classification (Bull. Geol. Soc. America, Vol. 39, p. 798, 1928) the *Deltopecten* beds, which contain these three species, then fall within the Upper Permian. *Clisiophyllum talboti* from the Irwin horizon closely resembles *C. turbinatum* from the Mountain Limestone of England. The Irwin horizon, however, is usually correlated with the Greta series which Schuchert places as high as Middle Permian. In the face of conflicting evidence such as this, the study of distribution of species can be of little use until the stratigraphical relationship of the various members of the Carboniferous or Permian-Carboniferous rocks of the State has been determined in the field.

* A single specimen of *Deltopecten* is recorded from Locality 5 but is apparently wrongly labelled, see footnote to locality table.

† Woolnough, W. G. and Somerville, J. S.—Roy Soc. N.S.W., Vol. LVIII, 1924, p. 91.
Campbell, W.D. G.S.W.A. Bulletin 38, 1910, p. 49.

III.—DESCRIPTION OF THE FOSSILS.

PHYLUM COELENTERATA.

CLASS ACTINOZOA.

Genus CLISIOPHYLLUM Dana.

(Edwards & Haime, Brit. Foss. Corals, p. lxx., Palaeont. Soc. 1850-54).

Clisiophyllum talboti, n. sp.

Plate III., figs. 1-3.

Description: Corallum simple, conical to turbinate, some individuals shorter and stouter than others; one specimen enlarges rapidly to a diameter of 30 mm. at about 35 mm. from the base. The calyx is circular to oval; the average diameter of a circular specimen is 22 mm.; one oval specimen has a longer diameter of 30 mm. and a shorter diameter of about 24 mm. The calyx is fairly deep with a thin edge. The epitheca is thick. The corallum is externally marked by longitudinal rounded ridges which in some places are not straight but slightly waved. These are crossed by irregular crumples and fine growth striae. The septa rise in the centre to form a false columella. About twenty septa stand out as ridges on the weathered surface of this central axis. Two of these, diametrically opposite, are stronger than the others and form a median crest. The central axis is about one-third of the diameter of the corallum. There are between 28 and 32 strong septa. Alternating with these are a series of rudimentary septa which are unequally developed on opposite sides of the calyx. None of the specimens have the margins of the calyx preserved entire. Several show the secondary septa on the higher part of the calyx preserved on one side but these are absent on the side broken off lower down. Probably were the entire margin present the secondary septa would be seen all round the calyx. They must have developed at a lower level on one side, however, as ground and natural sections towards the base of the calyx show their presence on one side and absence on the other.

Remarks: The specimens resemble *C. turbinatum* McCoy (*) in shape, size of the axial boss and prominence of axial boss and crest. The generic description of *Clisiophyllum* gives "septae rising towards the centre of the calice so as to form a spurious columella, but not twisted." In *C. turbinatum* the septa "bend slightly on the sides of a well developed lamellar columella." In the present specimens the septa viewed from the top of the calyx appear straight or only slightly bent at the columella. One specimen, however, from which the sides have been broken far down the cup exposing the columella, shows that the septa twist slightly round the columella as they ascend thus showing some affinity with the genus *Ptychophyllum*.

Descriptions of *C. turbinatum* do not mention ornamentation of longitudinal ribbing, but this is shown by a figure of *C. turbinatum* from the Mountain Limestone (Edwards & Haime, Fig. 1, pl. XXXIII).

(*) *Turbinolia fungites* (pars?), Fleming, Brit. Anim., p. 510, 1828.

Cyathophyllum fungites, de Kon. An. Foss. Terr. Carb. de Belg., p. 24, pl. D, fig. 2, 1842.

Clisiophyllum turbinatum, McCoy, Ann. Nat. Hist. Ser. 2, Vol. VII, p. 169, 1851.

Clisiophyllum Konineki, Milne Edwards and Jules Haime, Pal. Foss. des Terr. Palaeoz., p. 410, 1851.

„ *turbinatum*, McCoy, Brit. Pal. Foss. p. 88, and 96 figs. a, b, c, 1851.

Milne Edwards and Jules Haime, Mon. Brit. Corals, Pt. III., Corals Perm. Formn. and Mountain Limestone, p. 184., pl. 33, figs. 1, 1a, 2. Pal. Soc. 1852.

Although in general appearance these specimens are like *C. turbinatum*, they may be distinguished as a new species by the constant difference in the number and arrangement of the septa. Five specimens show between 28 and 32 septa as opposed to 44-54 of *C. turbinatum*. In four of these (the fifth is too poorly preserved) the rudimentary septa are visible on one side of the cup, but are scarcely discernible on the other.

I have named the species after Mr. H. W. B. Talbot who has contributed so much to the knowledge of the geology of this State.

Specimen Numbers : Geological Survey 4560 & 4962.

Genus PLEROPHYLLUM* Hinde.

(Geological Magazine (3) VII., p. 195, 1890).

Plerophyllum australe, Hinde.

Plate III., figs. 4-6.

1890—*Plerophyllum australe*, Hinde, Geol. Mag. (3) VII., p. 196, pl. VIIIA, fig. 1a-1f.

1903—*Pleurophyllum australe*, Etheridge, jun., Geol. Survey, W.A. Bull. 10, p. 8.

1907—*Pleurophyllum australe*, Etheridge, jun., Geol. Survey, W.A., Bull. 27, p. 27, pl. VII., fig. 1; Pl. VIII, fig. 1b.

1914—*Pleurophyllum australe*, Etheridge, jun., Geol. Survey, W.A., Bull. 58, p. 13.

The specimens from the Wooramel differ in external features from *Plerophyllum australe* as originally described by Hinde. They show fine regular longitudinal ribs with some irregular transverse crumples, but on the upper part of the calyx of three specimens the longitudinal ribs disappear and only fine transverse wrinkles are to be seen as shown in Hinde's figure 1b

Some years ago while examining numbers of small conical corals from Fossil Cliff, Irwin River, I noticed that among those having the typical structure of *P. australe* in cross section, were not only weathered examples with longitudinal furrows representing the median laminae of the septa (Hinde, fig. 1a) and pieces with concentric lines (Hinde, fig. 1b), but numbers of unweathered specimens showing external ribbing and a few showing the lower part of the calyx ribbed and the upper part concentrically striated. There is no doubt that these must be included in Hinde's species and, therefore, his description of the ornamentation of the species should be altered to read thus: "the exterior surface of this species when well preserved shows fine longitudinal ribs, which may disappear on the upper part of the calyx and their place be taken by fine concentric striae; when weathered the median laminae of the septa are shown as deeply impressed longitudinal lines or furrows."

Specimen Numbers : Geological Survey 4706. Department of Geology University—8491 & 8501.

* I can find no authority for the use of *Pleurophyllum* instead of the author's *Plerophyllum*, from πλεροφυλλος, full, in allusion to the way in which the corallum is filled up by stereoplasm.

PHYLUM POLYZOA.

Genus AETOMACCLADIA Bretnall.

(G.S.W.A. Bull. 88, 1926, p. 21).

Aetomacladia ambrosoides Bretnall.

Plate IV., fig. 4.

Aetomacladia ambrosoides, Bretnall, G.S.W.A., Bull 88, p. 21, pl.I., fig. 4.

Branches about 1-1½ mm. in diameter giving off secondary branches at right angles. The obverse is strongly keeled; each side of the keel is highly inclined, and bears diagonal rows of zoeia, usually three in an oblique row. Longitudinally the zoeia are in sub-alternating rows. Interzoeical surfaces smooth. Reverse surface smooth and rounded.

The only difference from the description of the type shown by my specimens is that the secondary branches are irregularly developed. Bretnall states "the offshoots are 5 mm. apart." I have some pieces 12 mm. in length with no sign of branches, and others on which secondary branches are only 3 mm. apart.

Specimen numbers: Geological Survey 46¹₄₈ D, 46¹₇₉ D, 46¹₆₄ D.

Department of Geology, University, 8499D.

Genus COSCINUM? Keyserling.

(Reise in das Petschoraland, 1846, p. 191).

Plate IV., fig. 5.

Several specimens of flattened encrusting bryozoa bear a slight resemblance to the holotype of Bretnall's *Coscinum? australe* (G.S.W.A. Bull. 88, p. 25). I can find no other specimen, figure or description which they resemble even remotely. This is probably due to there being very little literature on polyzoa available in Western Australia. I therefore record and figure these specimens as they are excellently preserved, hoping that they may be accurately identified later.

Description:—Flattened, encrusting zoarium. Zoecia arranged more or less in fluctuating rows, alternating in adjacent rows, five in the space of 3 mm. measured in any direction, apertures circular to pyriform, average diameter about .6 mm. Lunaria strongly developed. Interspaces vesicular, the vesicles directly adjacent to the zoecia forming rings of from 10-15 large vesicles round each zoecium.

Specimen Number: Geological Survey, 45¹₉₁.

Department of Geology, University, 8493.

Genus FENESTELLA (Miller), Lonsdale.

(Murchison's Silurian System, Pt. II, 1839, p. 677. Amended by McCoy, Brit. Pal. Foss. Fasc. I, 1855, p. 49.)

Fenestella affluensa, Bretnall.

Fenestella affluensa, Bretnall, G.S.W.A. Bull. 88, 1926, p.16, pl. I, fig. 8.

An examination of the holotype confirms the presence of this species amongst the polyzoa from the Wooramel shales.

Although Bretnall says it has "a delicate zoarium" and has "little in particular to distinguish it" it seems to me distinct in being a relatively stouter form than other species of this genus, as the interstices are broader than the fenestrules and the crossbars nearly as broad as the interstices. The interstices lack a medial carina and are almost flat, not raised like those of *F. horologia* and *F. fossula*.

Specimen Number : Department of Geology, University, G on 8499.

Fenestella horologia, Bretnall.

Plate IV., fig. 3.

Fenestella horologia, Bretnall, G.S.W.A. Bull. 88, 1926, p. 15, pl. I, fig. 6.

The hourglass shape of the fenestrules described by Bretnall is very distinctive, although this is not at all apparent in his figure. The specimens agree with descriptions of *F. horologia* in all particulars except the length of the fenestrules, which in my specimens is up to .57 mm.

The Wooramel specimens show many points of resemblance to *F. perelegans* Meek.* The very regular arrangement of the cell openings is the same; "a pore is always situated at each end of the dissepiments and one on the interstices between, that is, on the longer side of each fenestrule." On close examination (about $\times 20$) a row of fine accessory pores is seen making a wavy line on the crest between the two rows of zoecial apertures. "The non-poriferous side has rather a coarse longitudinal striation." Although the hourglass shape of the fenestrules is so marked in some parts of the zoaria there are other parts where the lateral margins of the fenestrules are no more waved than those shown by Waagen's, fig. 3b and 3c, of *F. perelegans*. As the "hourglass" structure is only caused by the projection of the zoecial apertures, this character alone seems scarcely enough to separate these forms from *F. perelegans* where the apertures are in exactly similar positions, but do not project quite so strongly. The fenestrules are slightly larger than in *F. perelegans* as there are only 8 in the space of 5 mm. as opposed to 10 in *F. perelegans* in the same space, measured both in the same direction as the extension of the branches and transversely. There is considerable variation in the breadth of the fenestrules from half to almost one and a-half times that of the branches, whereas in *F. perelegans* the width of the fenestrules is only half that of the branches. The larger fenestrules and proportionately thinner branches give the zoarium a more delicate appearance than that of *F. perelegans*. No longitudinal striations are discernable on the dissepiments, whereas these are present in *F. perelegans*.

Although the holotype of *F. horologia* (specimen 16 on 10930) is not to be found in the Geological Survey Collection,† the Wooramel specimens are identified as this species by the unmistakable "hourglass" shape of the fenestrules on parts of the zoaria. From other characters described above it is evident that *F. horologia* is closely related to, if not identical with, *F. perelegans* Meek.

Specimen Numbers : Geological Survey E on $46\frac{1}{4}8$, $46\frac{1}{4}9$ and $46\frac{1}{4}4$.

Department of Geology, University, E on 8499.

* 1871 *Fenestella schumardi* Prout? Meek in Heyden's Final Report on Nebraska, p. 153, pl.

VII., fig. 3.

.. *F. perelegans* Meek Ibid, p. 153, line 4 from below.

1885 *F. perelegans* Waagen Salt Range Foss. (Pal. Ind. Ser. XIII), I, 5, p. 777, pl. LXXXVII., fig. 1-3.

† A crumpled fragment of a *Fenestella* zoarium is labelled Holotype, but the distinguishing number and the greater part of the zoarium have been broken off. The remaining fragment, although slightly stouter, is very much the same as my specimen, but is too crumpled for accurate comparison.

Genus RHOMBOPORA, Meek.

(Pal. Eastern Nebraska, 1872, p. 141.)

Rhombopora mammillata, Bretnall.*Rhombopora mammillata*, Bretnall, G.S.W.A. Bull. 88, 1926, p. 24, pl. I, fig. 2.

One poorly preserved piece of this species is distinguished by the prominent diagonals, dividing the surface into a regular rhombic lattice work. Bretnall's figure gives no idea of this feature, but an examination of his holotype (10930 C2) shows that it is an unmistakable characteristic.

Specimen Number : Geological Survey, H on $46\frac{1}{88}$.

Rhombopora multigranulata, Bretnall.

Plate IV., fig. 2.

Rhombopora multigranulata Bretnall, G.S.W.A. Bull. 88, 1926, p. 25, pl. 1, fig. 3.

Zoarium cylindrical up to 2 mm. in diameter. Zoecia elongately oval from .2 to .3 mm. in longitudinal diameter. Interstices closely set with granules. The specimens differ from *R. multigranulata* as described by Bretnall, only in dimensions. The diameter of the zoarium is slightly greater, the apertures of the zoecia are slightly longer and the interstices proportionately wider, adjacent zoecia being separated by about their own width as in Bretnall's figure.

Specimen numbers : B on $46\frac{1}{88}$ & $46\frac{1}{79}$, Geological Survey.

B on 8499, Department of Geology, University.

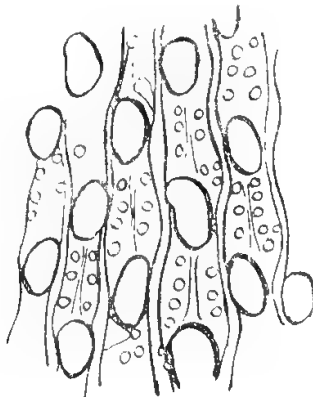
Genus STREBLOTRYPA Ulrich.

(Bull. Denison, Univ., IV., pt. 1, 1888, p. 84.)

Streblotrypa marmionensis, R. Etheridge, junior.

Plate IV., fig. 1 and Text fig. 1.

Streblotrypa marmionensis, Bretnall Geol. Survey W.A. Bull. 88, 1926, p. 22, pl. II., fig. 3, pl. I., not fig. 1 but fig. 7 ?



Text figure 1.—Camera lucida drawing showing arrangement of zoecia and mesopores (\times about 30).

Pieces of cylindrical zoaria from 1 to 2 mm. in diameter agree with Etheridge's description of this species (in Bretnall's paper) but not with his figure 1. plate 1. They show longitudinal rows of zoecia, with a longitudinal diameter of .21 mm. arranged in quincunx, separated by longitudinal carinae the lateral margins of the zoecia practically touching the carinae and, above and below the zoecia, polygons, variable in number, containing mesopores as he describes. Plate 1, fig. 1, shows no carinae but zoecia separated by one, or sometimes two, mesopores, in this agreeing with Bretnall's description of *S. etheridgei*. Plate 1, fig. 7, labelled *S. etheridgei*, on the other hand agrees with the description of *S. marmionensis* in having the longitudinal rows of zoecia separated by dense bands which seem to indicate ridges.

Unfortunately, the holotypes of *S. marmionensis* and *S. etheridgei* are in the Australian Museum, hence unavailable, but the collection which Mr. Bretnall returned to the Geological Survey of W.A. contains specimens labelled No. 1, *S. marmionensis* and No. 5, *S. etheridgei*. Of about six or seven of No. 1, all but two agree with the Wooramel examples, which are therefore called *S. marmionensis*. There is only one specimen labelled No. 5. This is quite distinct and could not be represented by Plate 1, Fig. 7. I would suggest, therefore, that the titles to the figures 1 and 7 were transposed in the press and that fig. 7 is *S. marmionensis*.

Specimen Numbers : Geological Survey C on 4688 & 4679.

Department of Geology, University, 8499C.

Genus SULCORETEPORA D'Orbigny.

(Prod. Palaeont. I., 1850, p. 152 ; for complete synonymy see G.S.W.A. Bull. 88, p. 16.)

Sulcoretepora meridianus, R. Etheridge, junior.

Sulcoretepora meridianus, Eth. jun. Bull. 88, 1926, p. 19, pl. 1, fig. 9.

A small portion (I on specimen 8499) from the south bank of the Wooramel, below Callytharra Spring, agrees with the holotype of this species.

PHYLUM BRACHIOPODA.

Genus AULOSTEGES Helmersen.

(Bull. Acad. Sci. St. Petersb. 1847, VI., p. 135.)

Aulosteges ingens, n. sp.

Plate V., figs. 1a-c, Plate VI., figs. 2a-c.

Description :— Shell slightly longer than broad ; ventral valve inflated, dorsal valve flat in the visceral region, but becoming concave towards the edges which are abruptly bent upwards, more or less at right angles to the plane of the valve. In the longitudinal direction the ventral valve is strongly arched anteriorly and posteriorly, but slightly flattened in the visceral region. Transversely the lateral slopes ascend steeply almost at right angles to the plane of the central portion, which is flattened and depressed in the central line by a well developed sinus. The hinge is slightly shorter than the greatest width of the shell. The lateral margins meet the hinge in a

blunted right angle ; they are almost straight posteriorly then curve rapidly to the anterior margin which is only very gently curved and slightly indented medially by the sinus ; thus the shell has a pronounced quadrangular outline particularly from the dorsal aspect. The umbo of the ventral valve is high, slightly overturned and slightly twisted. One specimen bears a flattened mark of attachment to some foreign body. The area is high and unequally developed on the two sides of the pseudodeltidium. The distortion of the umbo and area varies in the two specimens. On both specimens the margin on one side of the area slopes at a constant angle from the umbo to the end of the hinge line, but on the other side descends steeply nearly to the hinge line with only a very narrow prolongation of the area running to the end of the hinge line. One specimen has the abruptly narrowed side on the right, the other has it on the left of the pseudodeltidium.

The less weathered specimen shows the area ornamented with vertical striations. The pseudodeltidium is strongly vaulted with a median ridge, which, in the less weathered specimen, is rounded, but in the more weathered specimen is sharp, making the pseudodeltidium A-shaped in cross section. It is about 3 mm. broad at the base and tapers to a point under the umbo. It is marked with horizontal annulations. Where the area is much distorted the pseudodeltidium is twisted to one side. The cardinal process of the dorsal valve is broadly triangular coming to a sharp point under the pseudodeltidium.

Both valves are ornamented with spine bases which are finer and more closely set on the dorsal than on the ventral valve. On the visceral portion of the ventral valve they are large and regularly arranged in more or less alternating rows. The spines evidently ran for some distance in the test before emerging at the surface, particularly towards the anterior where this produces a faintly ribbed appearance on the exfoliated shell. Faint longitudinal grooves on the cast are also probably caused by this. Stout tubular spines are thickly set around the margin and on the ears of the ventral valve. A few concentric growth lines are faintly seen on the visceral portion of the ventral valve and towards the margin of the dorsal valve.

Where the shell has been removed showing the cast the muscle scars stand out as strongly and irregularly grooved patches slightly posterior to the centre of the shell. The internal characters of the dorsal valve are not exposed, but the septum can be seen through the shell extending over two-thirds of the length of the valve.

Dimensions :

	I.	II.
Length of ventral valve	59 mm.	....
Length of dorsal valve	45 "	....
Breadth	54 "	over 46 mm.
Thickness of combined valves	30 "	31 "
Hinge line	42 "	43 "
Height of area	9 "	9.5 "

Remarks : The only *Aulosteges* previously recorded from Western Australia is *A. baracoodensis*, Eth. jun.*. Judging by the shells included in this species by its author (see references 2 and 3 footnote) the limits of *A. bara-*

* 1903 *A. baracoodensis*, Eth. jun. Geol. Survey W.A. Bull. 10, p. 22, pl. II., fig. 1-2.

1906 *A. baracoodensis* var. *septentrionalis*, Eth. jun. Official Contrib. Pal. S. Aus. No. 55, 1906, Suppl. to Parliamentary Paper No. 55 (1906) 1907, p. 5.

Exclude 1914 *A. baracoodensis*, Eth. jun. Geol. Survey W.A. Bull. 58, p. 33, pl. IV., fig. 11-13.

coodensis are very hard to define. It seems almost impossible to exclude from the species any large *Aulosteges* which bears spines. On the other hand, I cannot reconcile the specimen before me with the description and figure of the type of the species.

The main differences are :—

Etheridge's type of *A. baracoodensis*.

A. ingens.

Rotundo-quadrate	More quadrate
Convexity of low degree	Convexity of high degree with very steep sides
Cardinal margins much shorter than greatest width of shell	Cardinal margins very little shorter than greatest width of shell
Cardinal angles obtusely rounded	Cardinal angles—right angles
Umbo blunt and barely overturned	Umbo overturned, slightly overhanging hinge line
Area not distorted; $\frac{1}{2}$ to $\frac{1}{3}$ rd width of cardinal margin	Area slightly distorted; the broad part $\frac{2}{3}$ rds to $\frac{6}{7}$ ths width of cardinal margin, but a narrow extension right to the end of the hinge line
Deltidium high and linear	Deltidium high but triangular.

A. ingens bears a general resemblance to a specimen of *A. dalhousi* figured by Waagen, Salt Ra. Foss. (Pal. Ind. 1884), pl. LXIII., 1a–c, but differs from the type of *A. dalhousi* (Davidson, Q.J.G.S., 1862, xviii., p. 33, pl. 2, fig. 7a and b), in being longer than wide, having the area less reclined and the hinge line proportionally longer.

Aulosteges ingens approaches nearest to an Indian specimen figured and described by Diener (Pal. Ind., 1903, Himalayan Fossils, Vol. I., pt. 5, p., 182, pl. VIII., figs. 13a–c) as *A. cf. gigas* Netschajew. This has a strongly convex ventral valve with the umbo slightly overturned, and the area curved. The dorsal valve is quadrangular, but no mention is made of upturned margins. Its dimensions are very similar to those of *A. ingens*, but it is slightly longer in proportion to its breadth. In addition to the ornamentation of spine bases, *A. cf. gigas* has a series of strong concentric wrinkles and also fine concentric striations. Neither of the specimens of *A. ingens* shows the complete shell, but the portion of shell which is seen shows only inconspicuous growth lines high on the visceral region. The umbo and area of *A. cf. gigas* are erect and not twisted, the deltidium is rounded with parallel margins, whereas that of *A. ingens* is tapering and in cross section is a pointed arch. *A. ingens*, therefore, although closely allied to the Indian species, differs in :—

- (1) the proportionately greater breadth;
- (2) the up-turned margins of the dorsal valve;
- (3) the unequal development of the area;
- (4) the slightly twisted umbo;
- (5) the shape of the pseudo deltidium;
- (6) the absence of concentric ornamentation.

Specimen Numbers : Geological Survey 4955 and 5000.

Aulosteges spinosus, n. sp.

Plate III, figs. 7 a–d.

Description.—A single specimen of a ventral valve is placed in the genus *Aulosteges* as it has a large area and a cardinal margin devoid of teeth.

The shell is small, as wide as long. The specimen is actually slightly wider than long, but as the anterior margin is slightly broken, the small difference would be easily made up were this margin entire. Valve is gently

convex, not at all swollen, greatest convexity posterior to the middle of the shell. A very faint, broad, shallow sinus appears towards the anterior margin. Umbo moderately high and not overturned. A faint mark on the umbo may be the point of attachment to some foreign body. Area is broad, extending the whole length of the cardinal margin; height about one-fifth of the length at the cardinal margin; slightly concave; not distorted; under low magnification shows numerous growth lines. A very distinctive feature is that the cardinal margin is recurved and erect so that a deep groove lies between it and the area proper. There is a narrow, highly arched pseudodeltidium which extends only half the distance to the cardinal margin, leaving a large open delthyrium widening considerably towards the cardinal margin where it is over 2 mm. across. The pseudodeltidium, under low magnification, shows a few growth lines, but no trace of spine bases.

The whole outer surface, other than the top of the umbo, is thickly covered with small perforated tubercles representing spine bases. On the slightly worn surface the spines can be seen as fine white lines running for considerable distances through the shell substance before emerging at the surface.

Internal characters.—An extraordinary feature of this shell is that although the specimen is well preserved and has been well cleaned, no definite traces of muscle scars can be observed. There are two very ill-defined rounded depressions, one on either side of the median line, about half-way to the anterior margin, and in these depressions are a few scattered pits. These marks are far too vague for any importance to be attached to them, unless later material shows them more definitely. Numerous irregular ridges lie on the inside of the shell, extending from the margin radially inwards for varying distances. Posteriorly some taper off imperceptibly, others terminate abruptly in a more or less bulbous end. These have no connection with the ornamentation of the outside of the shell directly behind them, but bearing in mind that the anterior margin of the specimen is broken, one may suppose that they represent spines which would have emerged from the exterior surface further towards the anterior margin or from the margin itself. On the other hand, the ridges present much the same appearance as the ridged and grooved surface of the muscle scars in the other *Aulosteges* in the collection, so here may represent portion of the muscle scars. In this case the shell must have been considerably longer.

<i>Dimensions.</i> —Length ....	....	....	....	20 mm. incomplete
Breadth .....	....	....	....	22 „
Depth of single valve .....	....	....	....	about 7 „
Length of cardinal margin ....	....	....	....	15 „
Height of area .....	....	....	....	3 „

Remarks.—The present specimen agrees with *A. baracoodensis* (recorded from the Wooramel River, G.S.W.A. Bull. 10, p. 22, pl. II, fig. 1–2a) in having a faint sinus in the ventral valve, the umbo blunt and barely overturned, the area not distorted and no spines on the deltidium. It differs in all other respects, viz.: it is a much smaller shell and was probably not longer than wide; its cardinal margin is not “much shorter than the greatest width of the shell” but only a little shorter; the cardinal angles are not rounded; the area is not so high and is broader; the deltidium is shorter, leaving a large open delthyrium; the ornamentation is of finer spines more closely set and regularly arranged; finally there are no concentric latilaminae.

The ornamentation of *A. spinosus* is more like that of specimens from north of Barrabiddie figured by Etheridge as *A. baracoodensis*, G.S.W.A.,

Bull. 58, p. 33, pl. IV, figs. 11, 12, and 13. Figure 13 shows the cardinal margin of the ventral valve which is apparently slightly recurved as in the present specimen. Etheridge's specimens are, however, much bigger, strongly convex shells on which the area is very small. Both specimens bear very little likeness to the type of *A. baracoodensis* and have been removed by Dr. Whitehouse to "*Taeniotheris*," a new genus of productids with *P. subquadratus* as type (Aust. Assn. Adv. Sc. Perth, 1926, p. 282, footnote 3, and p. 283, footnote 4). In any case the two points of resemblance between these and *Aulosteges spinosus* are not enough to reconcile the latter with Etheridge's description of the type of *Aulosteges baracoodensis*.*

A. spinosus differs from the type of the genus, *A. wangenheimi*, de Vern† mainly in the height of the umbo and the area on the ventral valve. Those of the latter are much higher and sharper and slightly distorted.

A. dalhousi Davidson‡ is, perhaps, the nearest to *A. spinosus* in shape and ornamentation. The main differences are: *A. dalhousi* has a pronounced sinus, *A. spinosus* only a faint one; in *A. dalhousi* the area is strongly reclined, making an angle of only a little more than a right angle with the plane of junction of the two valves, in *A. spinosus* the area is more erect and is not vertically striated as in *A. dalhousi*; the pseudodeltidium in *A. dalhousi* reaches nearly to the hinge line and is coated with small spines; *A. dalhousi* has not the recurved cardinal margin of *A. spinosus*.

The differences from all described species are so pronounced that the present *Aulosteges* must be placed in a new species despite there being only one specimen in the collection.§

It is to be noted, however, that the characters in which this specimen differs from *A. igens* (see p. 15) are all such as may change during growth, viz.: size, fineness of ornamentation, size of area, size of pseudodeltidium, distortion of umbo and area and irregularity of the shell. It is possible, therefore, that *A. spinosus* may represent the young form of *A. igens*. In the absence of intermediate forms the differences between them are too pronounced to allow their inclusion in the one species, especially as they came from different horizons, *A. igens* from the Deltopecten horizon and *A. spinosus* from the Irwin horizon.

Specimen Number : 4687 Geological Survey.

Genus CHONETES Fischer 1837.

(Oryctographie Gouv. Moscou, 1837, p. 13'.)

Chonetes pratti, Davidson.

1859 *Chonetes pratti* Davidson, Geologist, p. 116, pl. 4, figs. 9-12.

1892 " " Bull. Newton, Geol. Mag. IX (3), p. 542,
pl. XIV.

**A. baracoodensis* var. *septentrionalis*, Eth. jun. from Northern Territory, described in Official Contrib. Pal. S. Austr. Suppl. to Parliamentary Paper No. 55 of 1906, p. 5 and 6 shows no characters in common with *A. spinosus*.

† *Orthis wangenheimi*, de Vern, Murchison's Geol. Russia in Eur. 1845, ii, p. 194, pl. 11, fig. 5a. and b. *Aulosteges* Davidson, Brit. Foss. Brach. Pal. Soc. 1853, i, (Introd.) p. 116, pl. 9, figs. 212-215, id. Geinitz Dyas, 1861, p. 95, pl. 17, figs. 20 a-f.

‡ Quart. Journ. Geol. Soc. 1862, xviii., p. 33, pl. 2, figs. 7a and b.

Waagen, Salt Ra. Foss. (Pal. Ind.) 1884, i., pt. 4, p. 662, pl. 63, figs. 1 a-c.

§ Another specimen with all the same characters has recently been found in a collection from Fossil Cliff, Irwin River.

- 1903 *Chonetes pratti* Eth. jun., Geol. Survey W.A. Bull. 10, p. 23.
 1907 " " " " " " 27, p. 31, pl. VIII, fig. 2, pl. IX, fig. 7, pl. X, fig. 2.
 1914 " " " " " " Geol. Survey W.A. Bull. 58, p. 36.

There are numerous specimens of this well known species showing variations in form from that in which the hinge line forms the greatest width of the shell to one in which the greatest width is 20 mm. half-way towards the anterior margin, but the length of hinge line is only 15mm. There is also considerable variation in convexity of the ventral valve (up to 9 cm. in a valve whose length is 15 cm.) and in the depth of its median sinus. On some of the smaller more convex specimens the sinus is inconspicuous or altogether absent.

Specimen Numbers: Department of Geology, University, 8489, 8502.
 Geological Survey, 4684, 4672, 4657, 4988.

Genus CLIOTHYRIDINA Buckman.*

(Ann. & Mag. Nat. Hist. Ser. 7, Vol. 18, p. 321, 1906.)

Genus CLEIOTHYRIS King.

(Mon. Perm. Foss. Eng. 1850, p. 137.)

(*Cliothyridina* —) *Cleiothyris macleayana*, B. Etheridge, junior.

- 1889 *Athyris macleayana*, Eth. jun., Proc. Linn. Soc. N.S.W., iv. (2), p. 208, pl. 17, fig. 1-5.
 1890 *Athyris macleayana*, Foord Geol. Mag., vii (3), p. 149, pl. 7, fig. 3, p. 150, figs. B & C.
 1903 *Cleiothyris macleayana*, Eth. jun., Geol. Survey W.A. Bull. 10, p. 16, pl. III, fig. 10-20.
 1907 " " " " " " Geol. Survey W.A. Bull. 27, p. 21.
 1914 " " " " " " Geol. Survey W.A. Bull. 58, p. 23, pl. I, fig. 7.

This species is very plentiful at several localities on the Wooramel River. Most of the specimens are slightly crushed, but otherwise excellently preserved, showing the long spines fringing the lamellae. Two ventral valves show the variation in size of the muscle impressions noticed by Etheridge (Bull. 10, p. 17). One has a very marked septum and much elongated impressions as seen in Foord's fig. C., whereas the other has a much less conspicuous septum and much broader cardinal impressions.

Specimen numbers: Geological Survey 4686, 4671, 4650, 4677 and 4965
 Department of Geology, University 8488, 8498, 8504.

* S. Weller in "Mississippian Brachiopoda," State Geol. Surv., Illinois Mon. 1, 1914, p. 472, follows Buckman's use of *Cliothyridina* instead of *Cleiothyris*, King on the grounds that the name *Cleiothyris* was originally proposed by Phillips and if used at all must be used as a synonym of *Athyris*, over which it has priority.

Genus *DIELASMA* King.

(Dublin Natural History Review vol. VI, p. 519, 1859.)

Dielasma cymbaeformis Morris.

Plate VI., figs. 1a-1d.

- 1845 *Terebratula cymbaeformis* Morris in Strzlecki's Physical Deser. N.S. Wales & Van Dieman's Land, p. 278, pl. XVII., figs. 4, 5.
- 1877 *Terebratula sacculus* var. *cymbaeformis* Morris, de Kon. Foss. Pal. Nouvelle Galles du Sud. pt. 3, p. 257, pl. 15, fig. 4 (Mem. G.S., N.S.W., Pal. 6, p. 201, pl. 15, fig. 4)
- 1878 *Terebratula sacculus* var. *hastata* (pars) Eth. jun. Cat. Austr. Foss. 1878, p. 61.
- 1892 *Dielasma cymbaeformis*, Eth. jun., Geol. and Pal. Qld. Etheridge and Jack, p. 225, pl. 9, fig. 10 and 11.

A large example of this shell bears out Etheridge's opinion (Geology and Palaeontology of Queensland, p. 225) that *D. cymbaeformis* Morris is distinct from *D. hastata* Sby. and should be maintained as a separate species. The accompanying figures show the main distinguishing features of the species. The ventral valve is strongly curved longitudinally, but transversely flattened so that the valve is very shallow for its size. The umbo overhangs that of the dorsal valve. The foramen is large and obliquely placed. The dorsal valve is longitudinally almost straight but strongly arched transversely. There is no sinus in the ventral valve. The shell is ornamented with concentric growth lines.

<i>Dimensions :</i>	Length	....	....	....	60 mm.
	Length of dorsal valve	....	....	....	52 ,,
	Breadth	....	....	....	36 ,,
	Thickness	....	....	....	29 ,,
	Diameter of foramen	....	....	....	6-8 mm.

The specimen is unfortunately slightly crushed, but apart from the crushing the shell seems to have been unevenly developed. On the crushed side the shoulder of the ventral valve is high, on the other side the shoulder is much lower than figured by Morris or Etheridge. If the shell were equally developed with both shoulders low it would differ from *D. cymbaeformis* in having the greatest breadth further towards the anterior, but as the crushing does not seem to have affected the ventral valve, I hesitate to attribute to this cause the high shoulder of the ventral valve on one side and hence to separate the specimen from *D. cymbaeformis*. The inequality is probably due to irregularity of growth showing that the height of the shoulders is a variable feature.

Specimen Number : Geological Survey 4644¹.

Dielasma sp.

There are several small specimens of this genus in the collection, but they are too crushed or otherwise damaged for specific determination.

Specimen Numbers : Geological Survey 4662¹.

Department of Geology, University, 8494.

Genus *PRODUCTUS*, J. Sowerby.

(Mineral Conchol. 1814, i, p. 153).

Four species of this genus are recorded in the accompanying list of fossils from the Wooramel River District. As the specimens show no features additional to those already described* for these well known species, no further notes are necessary. Etheridge (G.S.W.A. Bull. 27, p. 30) has already pointed out that the Western Australian *Productus* recorded as *P. undatus* does not "appear to resemble the more typical forms of *P. undatus*," but a revision of this species is impossible here as there are only a few imperfect specimens in the Wooramel collection.

The majority of the *Producti* belong to the species *tenuistriatus* var *foordi*, Eth. jun. These are very fine specimens, up to 28 mm. in length and similar breadth, thus larger than the average individuals from the Irwin River beds.

Specimen Numbers :

	Geological Survey.	Department of Geology, University.
<i>P. semireticulatus</i> Martin	$\overline{4691}, \overline{4668}, \overline{4654}$	8496.
<i>P. subquadratus</i> Morris	$\overline{4655}$.	
<i>P. tenuistriatus</i> var <i>foordi</i> Eth. jun.,	$\overline{4683}, \overline{4690}, \overline{4669}, \overline{4656}$,	8487, 8495, 8505.
<i>P. undatus</i> DeFrance	$\overline{4667}, \overline{4677}, \overline{4689}$.	

Genus *RETICULARIA* McCoy.

(Synop. Carb. Lime Foss. Ireland, 1844, p. 142.)

Reticularia lineata Martin.

- 1858 *Spirifer lineata* Davidson Brit. Carb. Brach. Vol. ii, pt. V., p. 62, pl. xiii, figs. 1-13.
 1890 *Reticularia lineata* Foord Geol. Mag. dec. III., vol. VII., p. 153.
 1903 " " Eth. jun. Geol. Survey, Bull. 10, p. 16.
 1907 " " " " " " 27, p. 29.

(for complete synonymy, see Foord & Davidson, above).

The collection contains one ventral valve and two fragments of *Reticularia*. The ventral valve shows the typical ornamentation of *R. lineata* but is slightly wider than long, and has a well marked sinus thus corresponding to Davidson's description of *R. lineata* var. *elliptica* Phillips.

Specimen Numbers : $\overline{4674}, \overline{4661}$.

*See G.S.W.A. Bulletins, 10, 27 and 58.

Genus SPIRIFER J. Sowerby.

(Mineral Conchol. 1816, II., p. 41.)

Spirifer byroensis? Glauert.1912 *S. byroensis* Glauert, Rec. W.A. Museum, Vol. I., pt. II., p. 75.

1914 „ „ Eth. jun. Geol. Survey W.A. Bull. 58, p. 25, pl. IV., fig. 10 ; pl. V., fig. 5 ; pl. VI., figs 1-5.

A limonitic cast of a compressed elongately triangular shell with a low dorsal fold and traces of fasciculate ribbing may be a cast of the above species. It differs from the cast of *S. rostralinus* described on pages 26-27 in the shape of the process representing the muscle cavity. This is high but narrowed to a point, whereas that of the cast of *S. rostralinus* is broad and bluntly truncated.

Specimen Number : Geological Survey 4694^1 .

Spirifer hardmani Foord.1890 *Spirifer hardmani* Foord, Geol. Mag. Dec. III, Vol. VII., p. 146, p. 146, pl. VII., fig. 1, 1a.

1903 „ „ Eth. jun. Geol. Survey W.A. Bull. 10, p. 14, pl. 1, figs. 6 and 7, pl. 2, figs. 7-9.

Two incomplete ventral valves ornamented with radiating ribs and three or four ill-defined folds on each side of the sinus may be referred to this species. Etheridge remarks on the likeness of this ornamentation of *S. hardmani* to that of *S. musakheylensis*. In the latter, however, the bundles are more marked and in the Australian variety at least the central rib of the bundle is stronger than the others, whereas in *S. hardmani* the ribs are more or less equal. In the ill-defined character of the bundling *S. hardmani* is more like *S. ravana* Diener (Himalayan Foss. (Pal. Ind.) I, pt. 4, 1897, p.34, pl. III, figs. 1 and 2) but from this and from *S. marcoui* Waagen, Etheridge (G.S.W.A. Bull. 53, p. 24) distinguishes it by the length of the cardinal margin, which in *S. hardmani* is less than the greatest width of the shell. This is shown by one of the Wooramel specimens.

Specimen Numbers : Geological Survey, 4659^1 . (a)

Department of Geology, University 8490 (a).

Spirifer fasciger Keyserling = *Spirifer musakheylensis* Davidson.

Plate VII., figs. 1-3.

For reference and discussion of synonymy of *S. fasciger* and *S. musakheylensis* see :—

Diener, Himalyan Foss. (Pal. Ind.) 1897, i., Pt. 3, p. 43 ; pt. 4, p. 35 ; 1899, pt. 2, p. 63 and 1903, pt. 5, p. 106.

Foord, Geol. Mag., 1890, vii., dec. 3, p. 147.

Eth. jun., 1903, G.S.W.A., Bull. 10, p. 12.

Although there remains no doubt that *S. fasciger* and *S. musakheylensis* are identical and that Keyserling's name takes precedence of Davidson's, I

have retained Foord's name *S. musakheylensis* var *australis* for the Western Australian forms as this is so widely in use in Australian literature and collections.

Several incomplete specimens in the collection show considerable variation in the sharpness of the folds forming the bundles of ribs. One specimen is figured to show the sharp apical angle compared with that of *S. rostralinus* below. A specimen showing the interior of the ventral valve (fig. 2) is of interest as it helps to identify numbers of *Spirifer* casts. The muscle impressions are deep but do not extend far up into the beak which is filled with massive calcareous material. On the other hand the shell on either side of the dental plates just below the area is not very much thickened. The effect on the cast (shown by fig. 3, plate I of a plasticine impression) therefore, will be that the process representing the cavity for the muscles will be stout but will not project beyond the lateral portions of the cast.

Specimen Numbers: Geological Survey 4659^1 , 4686^1 and 4963^1 .
Department of Geology, University 8490.

Spirifer rostralinus, n. sp.

Plates VIII., VIIIA, IX., X. and XI., figs. 1 and 2.

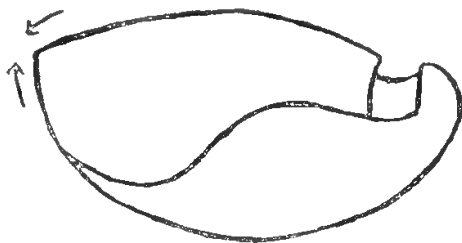
Spirifer casts Etheridge jun., Geol. Survey W.A., Bull. 58, p. 28,
Nos. 1 and 2, pl. III., figs. 2 and 3, pl. V., figs. 3 and 4.

The very large series of *Spirifers* described below is remarkable for the extreme variation in shape from a compressed elongated shell such as fig. 7, pl. VIIIA, to a stout form such as fig. 2, pl. VIII., and fig. 1a-d, pl. IX. After an examination of about thirty specimens and about twenty casts I find there is a continuous gradation from one shape to the other. As it is unlikely that collecting in other localities will yield such well connected series it may be convenient to separate the more alate and the stouter forms as two varieties, simply to give an easy means of reference. In this case, I suggest, the alate forms should be called *S. rostralinus* var. *auritus* and the thicker, less triangular forms *S. rostralinus* var. *crassus*.

The gradation from one form to the other is the effect of increase with advancing age in length and depth without a proportionate increase in breadth. If on one of the stouter forms the earlier growth lines are examined they will be seen to outline an alate form agreeing in every particular with specimens of the variety *auritus* such as fig. 7, pl. VIIIA.

The outline of the more alate forms is elongately triangular, the breadth being over two and a-half times the length. In the stouter forms growth at the anterior and antero-lateral margins has been more pronounced than at the postero-lateral margins, so that the breadth in these specimens is less than twice the length. As growth of the antero-lateral portion is so pronounced, the margin, instead of being straight, becomes curved and the shell seen from the dorsal surface is almost semi-circular in outline. This is not shown by most of the figures as these were taken, looking vertically down on the fossils. Figure 1a, plate IX, however, taken with the shell tilted backwards slightly, shows this outline, which at first glance seems to constitute a striking difference between these and the more alate specimens. The greater depth shown by the larger forms is also the effect of growth.

During growth the anterior margins of the valves are curved towards one another and as each valve grows towards the margin of the other, the two are pushed farther and farther apart.



Text figure 2.

Diagram to show the direction of growth of the valves causing increase in depth with age.

Although these changes in outline take place during growth the more alate shells are not always the smaller as apparently some change their outline at a later stage than others, for example, fig. 4, pl. VIIIA. shows a large shell of the variety *auritus* and fig. 8, pl. VIIIA. a smaller shell of the variety *crassus*.

The shells are ornamented with radial ribs grouped into bundles. This grouping dies out towards the wings and towards the anterior margin. It is much more marked in some specimens than in others; in one it is only to be seen on the umbonal flanks, others have strong bundles which must have been even more marked on unweathered specimens. From three to five ribs form a bundle. Near the umbo the centre rib of each bundle is stronger than those on either side. As the bundles die out the ribs become more delicate and equal. Most of the specimens are exfoliated and have the ends of the wings devoid of ribs, but a few of the better specimens have faint ribs extending almost, if not quite, to the tips of the wings. Both the fold and the sinus are ribbed. The surface of the shell was probably covered with concentric "frill lamellae" such as those of *S. musakheylensis*. These are indicated on the worn surfaces of the shells by innumerable fine fibrous lines parallel to a few stronger growth lines. External impressions accompanying the limonite casts mentioned below also show the presence of these raised frilled lamellae.

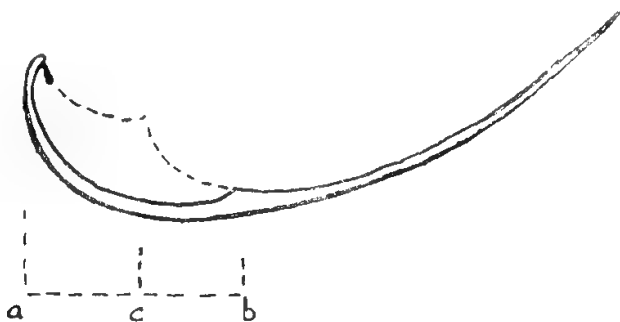
The valves are about equally inflated. Their convexity has already been referred to in dealing with changes taking place during growth. In the ventral valve the curvature is stronger longitudinally than transversely. The transverse curvature varies in different specimens: the alate forms are almost flat transversely, but as growth proceeds the margin is bent dorsally so that in the larger specimens the curve is much more pronounced. The sinus is broad, but varies in depth in different individuals. In some of the alate forms it is quite shallow, but in the larger forms it is pronounced causing the anterior margin of the valve to bend sharply forward. On the umbo it is limited by folds, but anteriorly the limits become indistinct. On the umbo a single rib lies in the sinus. Extra ribs appear by interpolation so that at the margin of a small specimen there are about eight ribs in the sinus. These multiply until, in a large specimen, there are a considerable number, possibly between 15 and 20. Unfortunately, none of the large specimens is well enough preserved to show the limits of variation in the number of ribs lying in the sinus. The central rib which commences high on the umbo is stronger than the rest. This is well shown by several of the

smaller specimens, see fig. 7b, pl. VIIIA. One of the large specimens shows this pronounced rib bifurcating at about half the distance to the anterior margin, giving rise to two ribs equal in size to the others lying in the sinus.

The dorsal valve is very variable in curvature. Longitudinally the lateral parts may be flattened or strongly convex. The curvature increases with age. The fold is strong and elevated considerably above the general convexity of the shell. On either side of this the shell is flattened transversely, but towards the wings tends to curve upwards. This is noticed on only one of the smaller shells on which the lateral portions are usually almost flat transversely. It is a common feature of the larger shells, showing that it is acquired with age. The dorsal fold commences as a high plain rib but other ribs are added by interpolation, so that at the margin the fold bears about twenty ribs. Of these, five on each side belong to a bundle of ribs flanking the primary fold high on the umbo. None of the specimens shows distinctly whether the crest of the fold is a median rib more pronounced than the rest or whether all the ribs are approximately equal. To all appearances, however, the central rib is pronounced at first, but towards the anterior is split up into two subsidiary ribs equal in size to those on either side.

Both umbos are very small, scarcely raised above the upper margin of the area, so that the valves have a very wide apical angle. The area of the dorsal valve is narrow and flat with parallel margins. That of the ventral valve is broad, gently reclining, concave, and has nearly parallel margins. It is marked vertically with wavy striae and horizontally with straight growth lines. The delthyrium is very broad and is closed in for less than one-third of its length by a deeply sunken deltidium which is flattened laterally, but has a raised median ridge.

In the interior of the ventral valve the depression for the muscle attachments is very deep and extends high up under the umbo. In the region of this depression the shell is comparatively thin. On either side of the dental plates the shell is very much thickened, all that portion behind the area of the ventral valve being filled in with calcareous material. On the cast the effect of this is that the process representing the cavity for the muscle impressions is very stout and very much elevated above the body of the cast, see text fig. 3, which explains the apparent anomaly of a shell with such a low umbo being identified with casts mentioned below, on which the prominent cast of the muscle cavity seems to indicate a high umbo on the shell.



Text figure 3.

Showing relation of section of the shell through the umbo to a section (shown by dotted line) taken on the other side of one of the dental plates where the shell is solid behind the area. Thus the distance a-b represents the length of the cast of the muscle cavity and distance a-c its elevation above the cardinal margin of the cast.

A single specimen in the collection serves to connect a large series of limonitic casts from Bogadi Outcamp with the shells described above. This specimen has the typical dorsal valve of *S. rosalinus*, but the ventral valve has been removed showing the high cast of the muscle cavity referred to above which is so characteristic a feature of the series of limonitic casts. see pl. X. and pl. XI, figs. 1 and 2. These are particularly interesting as they establish the identity of casts described by Etheridge, G.S.W.A. Bull. 58, p. 28, Nos. 1 and 2, pl. III, fig. 2 and 3, pl. V, fig. 3 and 4. They show the same variation in shape as the testiferous specimens and include forms such as Etheridge's No. 1 as well as more alate forms such as his No. 2. The fasciculate ribbing is always better shown on the dorsal valve of the cast. On the ventral, the ribbing is only shown towards the anterior margin. On the visceral portion the surface of the cast is covered with tiny granulations on either side of the strong muscle impressions.

Dimensions of a typical Series of Shells : —

	I.	II.	III.	IV.	V.	Type of <i>Spirifer</i> <i>byroensis</i> .
Length of shell	63 mm.	52 mm.	over 41 mm.	37 mm.	26 mm.	37 mm.
Length of dorsal valve	51 "	45 "	34 "	32 "	22 "	27 "
Length of hinge line	100 "	95 "	94 "	78 "	70 "	97 "
Thickness of both valves*	41 "	34 "	29 "	25 "	17 "	21 "
Apical angle of ventral valve† ...	158°	157°	157°	156°	abt. 150°	158°
Apical angle of dorsal valve ...	142°	144°	144°	149°	abt. 146°	...
Height of area of ventral valve ...	11 mm.	8 mm.	7 mm.	4 mm.	...	9 mm.
Height of area of dorsal valve ...	2 "	2.5 "	...	...	...	...

Remarks. These shells are allied to *S. nitiensis* Diener** and to *S. musakheylensis* Davidson§ and form a series parallel to that shown by Diener (Himal. Foss. I, pt. 5, p. 106 and 107) to exist between these two species.

The alate forms of *S. rosalinus* are closely comparable to *S. nitiensis*. Diener's description of the type of *S. nitiensis* gives the "breadth three times the length." He later modifies this, describing further specimens in 1903. The specimens before me exhibit proportions between those of his type of 1897 and the specimens figured in 1903. The ribbing is similarly grouped in bundles, but, in *S. nitiensis*, Diener describes ten fasciculi on either side of the fold or sinus before the bundling dies out. These, however, are in distinguishable in his figures in which, as in our specimens, only three or four bundles are at all well marked. There is a similar strong rib in the centre of the sinus and the fold is similarly costate. The only other character by which *S. nitiensis* may be distinguished from *S. rosalinus* var. *auritus* is the prominence of the umbo. Although the umbo of *S. nitiensis* is "but slightly produced beyond the cardinal edge" that of *S. rosalinus* is even less produced, and makes a gentle slope continuous with the slope of the posterior edge of the area, so that the apical angle is very wide, 150° to 160°, in contrast with that of the type of *S. nitiensis* in which the apical angle is 144°.

The low umbo and wide apical angle again are the main features separating the larger members of *S. rosalinus* from *S. musakheylensis* in which the apical angle is only 130°. The young shells of *S. rosalinus* differ markedly from those of *S. musakheylensis*. In the younger forms of *S. musakheylensis* the hinge line is always shorter than the greatest breadth of the shell. The

* Measured from fold to point opposite in the sinus.

† Measured only on rostral portion; the apical angle of the ventral valve, measured from end to end of the hinge line, is between 161° and 166°.

***S. nitiensis* Diener Himalayan Foss. Pal. Ind. 1897 I, pt. 4, p. 41, pl. IV, fig. 4 and 5 a-e; 1899 I, pt. 2, p. 65, pl. V, fig. 9; 1903 I, pt. 5, p. 106, pl. IV., fig. 6-7.

§ Waagen Salt Ra. Foss. (Pal. Ind.) 1883, I, pt. IV, Fas. 2, p. 512, pl. 45 and previous references.

growth lines of *S. rostralinus* outline a very alate form in which the breadth is over twice the length and show that even in the earliest stages the hinge was never shorter than the greatest breadth of the shell. The majority of Waagen's figures show the transverse convexity of the ventral valve less than that of the dorsal, whereas in these specimens the conditions are reversed. In many specimens the convexity of the ventral valve transversely is further accentuated by the upward curve of the wings of the dorsal valve. This also causes a difference in the line of junction of the two valves as seen from the side, compare text fig. 2 with Waagen's figs. 1c and 2c. The only *Spirifer* in which I have seen a similar upward lifting of the wings of the dorsal valve is *S. marcoui*, figured by Diener, Himalayan Foss., Pt. V, pl. IX, fig. 1d. *S. marcoui* has been recorded from Western Australia by Etheridge, G.S.W.A. Bull. 58, p. 23, pl. 1, figs. 5-6, pl. 2, figs. 8-9, but this is easily distinguished from *S. rostralinus* by the character of the ornamentation which is much finer in *S. marcoui*. *S. rostralinus* has only about 60 or 70 ribs grouped into bundles whereas *S. marcoui* has about 120 ribs with only very slight traces of bundling.

Another *Spirifer* which may be compared with the alate variety of *S. rostralinus* is the Western Australian *S. byroensis* Glauert.* Mr. Glauert has kindly allowed me to examine his types of this species (W.A. Museum, Nos. 1650 and 1651). From these I find there is more likeness to *S. nitiensis* and hence to the Wooramel specimens, than would be supposed from Etheridge's detailed description and comparisons. According to Etheridge the ornamentation of *S. byroensis* shows less "tendency to fasciculation" than that of *S. nitiensis*, thus agreeing with *S. rostralinus*, although as I have remarked above, the figures of *S. nitiensis* do not show fasciculation to the extent described by Diener. Etheridge also says that the alar extensions of *S. byroensis* are ribless. Those of *S. rostralinus* are possibly ribbed. The presence of ribbing on the wings in *S. byroensis* is just as debatable as in *S. nitiensis* and in *S. rostralinus*. I have examined the specimens described by Etheridge and find that in three of these and in Mr. Glauert's types the wings are obscured by a film of limonite; in another specimen, the original of pl. V, fig. 5, G.S.W.A. Bull. 58, although the ribs become very much fainter, they are still to be seen on the wings, even though the shell here is slightly worn. Bearing in mind that the more delicate ribs are lost in slightly worn specimens, it seems possible to use this point in separating species only when excellent specimens are available. Again, the prominence of the sinus and fold of *S. byroensis* is doubtful. Etheridge says "the depth of the sulcus is much less and the brachial fold is less prominent in *S. byroensis* (than in *S. nitiensis*). In consequence of this the anterior wave of the united valves is straighter and there is an absence of the strong forward median projection of *S. nitiensis*." The half specimen shown on pl. V, fig. 5, Bull. 58, certainly has a flat fold and no median projection, but as Mr. Glauert's types and all the other specimens identified by Etheridge are unfortunately crushed and considerably damaged at the margin and, among these, one or two undoubtedly show the beginning of a high fold, it is impossible to say whether or not the low fold and absence of median projection are variable features.

Apart from these debatable points the only constant differences between *S. byroensis* and *S. nitiensis*, namely, the height of the umbo and the size of the apical angle, are the same as those separating *S. nitiensis* from *S. rostralinus* var. *auritus*. The apical angle of *S. byroensis* is 158° measured

**S. byroensis* Glauert Rec. W.A. Museum, 1912, Vol. I., pt. II., p. 75.

,, ,, Etheridge G.S.W.A. Bull. 58, 1914, p. 25, pl. IV, fig. 10, pl. V, fig. 5, pl. VI, figs. 1-5.

at the rostral portion, or 165° measured from end to end of the hinge line. In this as in most other characters it agrees with *S. rostralinus*, from which it is to be distinguished only by its extreme elongation transversely, the compression of the united valves and possibly a shallower fold. The measurements of the type of *S. byroensis*, number 1650, are given on page 27, for comparison with those of *S. rostralinus*.

It is probable that *S. byroensis* belongs to the same group as *S. rostralinus* but represents a form in which growth with old age takes place more at the cardinal margins than at the anterior margin, thus accentuating the alate form of the shell. It will be interesting to see whether further collecting shows the presence of forms intermediate between *S. byroensis* and the alate *S. rostralinus*. If these are present two series of variations with advancing age may be shown starting from *S. rostralinus* var. *auritus*, varying in the one direction to a progressively stouter shell, *S. rostralinus* var. *crassus*, and in the other direction to a progressively broader form, *S. byroensis*, which is more compressed in proportion to its breadth, owing to slower growth at the anterior margin. As there are no intermediate forms in the collection before me, I cannot unite these specimens with *S. byroensis* Clauert, but must separate them as a new species.

Summarising the characteristics of *S. rostralinus* these are : exceptionally low umbo, wide apical angle, broad area with almost parallel margins, pronounced fold and sinus both ribbed, coarse ribs grouped in bundles near umbo, 4-5 bundles each side of fold or sinus, bundles dying out towards anterior and on wings.

Specimen Numbers : 46^146 and 46^192 Geological Survey.

$4_9^1 4_9^1$ almost complete series „ „

Var *crassus* $\frac{4}{4} \frac{6}{6} \frac{4}{4} \frac{9}{9}$ " "

8480, 8483, 8477, Department of Geology, Univ.

Var *auritus* $\frac{461}{441}$ and $\frac{461}{333}$. Geological Survey.

8484, 8975, and 8976, Department of Geology,
Univ.

Genus SPIRIFERELLA Tschernyschew.

(Mém. Comité. Géol. Russie, 1902, XVII., No. 2, pp. 121, and 522.)

Spiriferella australasica, R. Etheridge, junior.

1899 *Cyrtina carbonaria* var. *australasica*, Eth. jun. Proc. Linn. Soc. N.S.W. IV. (2), p. 210, pl. XVII., fig. 6-8.

1907 „ „ „ „ Eth. jun. Bull. G.S.W.A. No.
27. p. 21.

1914 *Spiriferella australasica* Eth. jun. Geol. Survey W.A. Bull. No. 58,
p. 30, pl. V., fig. 6 13.

Numbers of specimens of this species are present in the collection but none of these have the outermost shelly layer preserved to show whether or not this is punctate.

Specimen Numbers : Geological Survey, 46158, 46166, 46181, 46191, and 49644.

Department of Geology, University, 8497.

Genus STROPHALOSIA King.

The specimen recorded on the locality chart as a member of this genus, registered as Geological Survey Specimen 46¹/₇₃, was in an excellent state of preservation and undoubtedly represented a new species. It has since been lost, therefore description and figures are worthless until further specimens are available.

PHYLUM MOLLUSCA.

CLASS LAMELLIBRANCHIATA.

Genus CARDIOMORPHA de Koninck.

(Anim. Foss. Terr. Carb. Belg. 1842, p. 101.)

Cardiomorpha blatchfordi, n. sp.

Plate VII., figs. 4a and 4b and fig. 5).

Pachydomus? Eth. jun. Geol. Survey W.A. Bull. 58, p. 36, pl. VII., fig. 3.

Casts of an equivalve, oblique, inequilateral shell are placed in this genus as they possess an apparently edentulous hinge. The umbones are high, strongly recurved and directed forward. The line of greatest convexity runs obliquely from the umbo to the posterior ventral margin. On one side of this the shell slopes abruptly to the posterior margin, on the other side it is gently rounded with a very slight flattening towards the anterior margin. The anterior portion of the shell is narrowed. Two specimens show a very faint trace of a sinus in the anterior third of the ventral margin. The pallial line lies near the ventral margin and is without a sinus. The anterior muscle scar is pear-shaped, and deeply impressed, particularly on the posterior side, so that on casts its margin is sharp and ridge-like. The posterior muscle impression is rounded, larger and placed higher than the anterior one and is not so deeply impressed. The hinge is deeply sunk. On two casts the line of junction of the two valves immediately below the umbo has a slight twist, but the hinge plate appears to have been without teeth. A line near the posterior dorsal margin probably indicates the position of the escutcheon.

Many of the casts show a remarkably regular ornamentation of coarse concentric sulci. These are particularly well marked in the smaller specimens and are not so well marked in those showing the muscle markings. Apparently those in which it is so pronounced are more in the nature of partial replacements than true internal casts. In the larger specimens the sulci become obsolete on passing over on to the posterior slope. The only portion of shell shown adhering to one of these specimens is near the anterior margin. It is fairly thick, with an ornamentation of very fine concentric lines with three regularly spaced coarser striae. The latter probably correspond to the coarse rugae of the casts.

Dimensions :			I.	II.	III. Small indi- vidual.
Antero-posteriorly	....	....	43 mm.	51 mm.	16 mm.
Dorso-ventrally	....	...	40 "	48 "	15 "
Thickness	....	....	32 "	40 "	9 "

Remarks : The limonitic cast figured by Etheridge as *Pachydomus?* closely resembles the casts described above. Etheridge mentions a resemblance to *P. ovalis* (McCoy, Ann. Nat. Hist. 1847, XX., p. 302, pl. 14, fig. 4) which, however, differs in its regular outline, slight convexity, rounded muscle impressions, and possession of a slight pallial sinus.

Although similar shells from the Permo-Carboniferous rocks of Australia have been described by de Koninck and others under the genus *Pachydomus*, I have followed Hinde (Carboniferous Lamellibranchiata pt. III.,

p. 255 and p. 259, Pal. Soc. for 1898) in placing these in the genus *Cardiomorpha* as they lack the teeth and "antiquated area" of *Pachydomus*. At the same time, as Hinde notes, the concentric ornamentation is coarser and apparently the muscle marks are deeper than in the typical *Cardiomorpha*.

The species is named after Mr. T. Blatchford, Government Geologist, through whose kindness I have been able to examine not only this collection, but all previously identified fossils now in the Survey collection.

Specimen Numbers : Geological Survey 4542, 4946, 4951 and 4999.

Cardiomorpha, n. sp.

Plate VII., fig. 6.

A single imperfect specimen may represent the exterior of the species *Cardiomorpha blatchfordi* as it agrees fairly well in shape with the casts described above. The shell is ventricose, slightly inequilateral, with the anterior narrowed from above downwards and the anterior border semi-circular. The inferior border is slightly convex, sloping obliquely to the posterior margin, which is damaged in this specimen. The body of the shell is gently rounded, but from an oblique rounded ridge on the posterior side it descends abruptly to the posterior margin. The umbones are high above the hinge line, prominent, swollen, incurved, touching one another and directed forward. The shell is thick and ornamented with fairly coarse concentric ridges which are pronounced anteriorly but become obsolete as they pass on to the abrupt dorsal slope.

Dimensions :

Antero-posteriorly	....	....	more than 58 mm.
Dorso-ventrally	....	....	55 "
Thickness	....	....	42 "

Remarks : Comparing this description with that of the casts of *C. blatchfordi* one can find no distinguishing features except that the ornamentation of this shell is not what one would expect for *C. blatchfordi*. The concentric ridges are too fine to leave coarse folds and sulci on the cast. However, at fairly regular spaced intervals there are heavier concentric ridges which become more like coarse folds or wrinkles towards the ventral margin. Bearing in mind that the small piece of shell adhering to one of the above casts of *C. blatchfordi* was also finely striated with a few heavier striae it is quite possible that this specimen may be the same species. As it is found at a different horizon unaccompanied by casts, its identity cannot be proved until further specimens are available.

In convexity and ornamentation the specimens recall *P. globosus* Sowerby,* but no figures of the latter show an abrupt posterior slope although Etheridge (Geol. and Pal. Qld., p. 283) mentioned a rounded diagonal ridge when speaking of the thickness of his specimen. The proportions differ from those of *P. globosus* in which the length from anterior to posterior is considerably greater than that from dorsal to ventral margin. On the whole the figured specimens of *P. globosus* vary so in outline that it is quite possible that this specimen could be included in the limits of the species, which, however, is not a very well-defined one since the only characters linking together the various specimens described under the name seem to be the swollen shell and the coarse concentric ornamentation.

Specimen Number : 4701 Geological Survey.

**Megadesmus globosus* Sowerby in Mitchell's Three Expedit. Interior of Eastern Australia, Vol. 1, p. 15, pl. 2.
Pachydomus " Morris, in Strzlecki's Phys. Descr. N.S.W., pl. X., fig. 2 and 3.
 " " de Koninck Pal. Foss. Nov. Galles du Sud. 1877, pt. III., p. 272, pl. 18, fig. 5. (G.S.W.A. Pal. Mem. 6, p. 214, pl. 18, fig. 5).

Genus DELTOPECTEN R. Etheridge, junior, 1892.
(Geol. and Pal. Queensland and New Guinea, p. 269.)

Deltopecten subquiquelineatus, McCoy var. *comptus* Dana.

Plates XII. and XIII.

- 1847 *Pecten comptus* Dana Am. Journ. Sci. (2) IV., 1847, p. 160.
1906 *Deltopecten subquiquelineatus*, (pars) Eth. jun. and W. S. Dun. Geol. Surv. N.S.W. Mem. Pal. 5, Vol. II., pt. I., p. 26.
1907 ,, ,, Eth. jun. Geol. Survey, Bull. 27, p. 22, pl. 5, figs. 1-3.
1910 ,, ,, L. Glauert, Geol. Survey, Bull. 36, p. 91.
1914 ,, ,, Eth. jun. Geol. Survey W.A. Bull. 58, p. 36, pl. 8, fig. 1.
1929 ,, *comptus* Fletcher, Records, Aus. Mus. Vol. XVII., No. 1, p. 23, pl. XIII., figs. 1-4.

The description below is based on an examination of a series of sixteen testiferous specimens in a sandy matrix and over forty limonite casts and partly testiferous specimens from the Wooramel District. Unfortunately, only three or four of these specimens have the margins unbroken, although they are otherwise well preserved and show hinge, ears and ornamentation very clearly.

The shell is orbicular, equilateral, inequivalve. The left valve is convex, the right valve flat or very slightly convex. The cardinal margins are less in length than the greatest antero-posterior measurement of the shell; the ratio between the two varies slightly with the size of the shell, but is about two-thirds in an individual in which the antero-posterior measurement is 3in. Antero- and postero-ventral margins are semi-circularly rounded. The hinge area of both valves is broad, showing numerous fine resilium furrows and below each umbo a broad, semicircular, concave chondrophore, concentrically striated by a continuation of the resilium furrows.

Left-Valve.—Convex, umbo moderately tumid, pointed. The ears are large wedge-shaped, flattened, almost equal, the anterior slightly larger than the posterior and separated from the body of the valve by a slightly steeper slope. On the inside of the shell where the ear joins the body of the shell there is a more pronounced ridge on the anterior side than on the posterior. This leaves a well-marked insinuation on the cast as figured by Etheridge, G.S.W.A. Bull. 27, pl. 5, figs. 1-3. The posterior ear is pointed at the dorsal margin, the anterior is bluntly rounded, with a slightly convex margin. The margin of both the anterior and the posterior ear has a broad concave insinuation just before its junction with the anterior and posterior margins of the shell. Ears and body of the shell show a few widely spaced growth lines. On the ears there are fine radiating ribs which are close and in most cases equal. On the better preserved specimens these are crossed by very fine growth lines raised into lamellae. On even slightly worn specimens however, these lamellae are lost and the ribs appear unbroken by any transverse ornamentation. On the body the ribbing is extremely variable. On the umbo one can count sixteen to twenty-two ribs, a coarser alternating with a finer. The latter, however, rapidly attain the same size as the former, so that lower on the shell they cannot be distinguished as two series. The ribs on the umbo are steeply rounded, but rapidly become broad and flattened. At the margin of the larger specimens the primary ribs are from 5-7 mm. apart. Between each of the broad primary ribs on the body of the shell, is a secondary and on either side of this a variable number of

tertiary ribs. In many places the arrangement given by McCoy for *D. subquinculineatus*—one secondary flanked by two tertiaries—is to be seen. In other parts of the shell the arrangement is quite irregular as there may be:

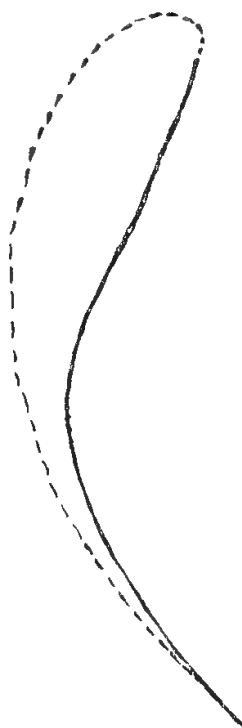
- (a) no tertiary ribs ;
- (b) no secondary, but from two to six finer ribs ;
- (c) a secondary with an unequal number of tertiaries on either side.

The coarseness of the primary ribs is also variable. Where there is only one tertiary rib between the primary and secondary, the primary ribs in many cases conform to McCoy's description of "coarse narrow rounded ridges," but on the average large specimen they are broad and flattened. On large specimens below about the third or fourth growth line, the broad primary and the larger of the secondary ribs divide up into a number of finer ones, the broader ones giving rise to as many as six fine striae, nearly equal in strength to the tertiary ribs. On the body of the shell the ribs are quite smooth without transverse striae, but near the margin of larger shells where the broad ribs are subdivided into finer ones there are indications of a concentric ornamentation of very close fine laminae. Some of the specimens are slightly exfoliated on the main body, and here the test is silky and fibrous, the fibres having a general concentric arrangement.

Right Valve.—Most of the specimens are flat. One specimen of the united valves has the visceral portion convex, but becomes flattened and slightly concave towards the margins, see text fig. 4. A similar outline is figured by Etheridge and Dun, pl. XIII, fig. 2. Two internal casts of large right valves have the visceral portion almost flat, but the marginal portions abruptly bent back and closely pressed against the left valve. Text fig. 5 shows in cross section the outline of one of these casts with the approximate position of a left valve drawn from another specimen shown by the dotted line.



Text Fig. 4.



Text. Fig. 5.

Text. figure 4.—Cross section of small specimen, showing slight concavity of right valve towards the margin.

Text figure 5.—Cross section of cast of a large concave right valve with dotted line indicating the position of the left valve.

The compression of the shell may be due to crushing, but as several smaller specimens show the beginnings of concavity around the margins of the right valve it is probable that this reversal of curvature becomes more pronounced with age. The umbo is inconspicuous. The posterior ear is broad and flat, separated from the body of the shell by only a very slight slope, and is the same size and shape as the posterior ear of the left valve. The right anterior ear is smaller than the left anterior. Its outer margin is convex and slopes abruptly backwards. It is separated from the main shell by a deep narrow byssal sinus. The surface of the right anterior ear shows raised lamellae crossing the ribs, breaking them into rows of granules. The ribbing on the right valve is much simpler than that on the left. A second series of ribs arises about half-way to the anterior margin. These rapidly attain the same size as the primary ones. On an individual, two and a-half inches long, near the margin, is a series of very fine threadlike ribs, alternating with the larger ribs. The latter are never as broad nor as flattened as the primary ribs on the left valve of the same individual. The spaces between the ribs on the right valve are broader than the ribs themselves.

Casts.—The majority of the limonitic specimens are casts. On these the ribbing is much less distinct, as is to be expected on an internal cast. Some show a few tertiary ribs, others only secondary ribs and others even only show primary ribs. Their identity with the many-ribbed testiferous specimens is proved by examining a number of partly testiferous specimens showing less pronounced ribbing on the cast in places from which the shell has been removed. The resilium area of the hinge appears narrower on the casts (Eth. jun. G.S.W.A. Bull. 27, p. 22, "hinge line narrow") as the resilium is mostly external and therefore is not entirely shown on an internal cast.

<i>Dimensions :</i>	I.	II.	III. Small indi- vidual with flat right valve.	IV. Small indi- vidual with convex right valve.
Dorso-ventrally	75 mm. (approx.)	62 mm.	43 mm.	40 mm.
Antero-posteriorly	85 mm.	62 "	....	....
Thickness of united valves (about)....	25 "	18 "	11 "	14 "

Remarks.—The Wooramel *Delotpectens* agree in all essential characters with *D. subquiquelineatus* McCoy,* but show coarser ribbing than the majority of specimens figured under this name. Although McCoy's original figure shows the anterior ear of the left valve with a deeply convex margin meeting the anterior margin of the shell at an acute angle, no later figures of the species show† this, as most are too imperfect in the region of the ears for use in comparison. Specimens from Western Australia figured by Etheridge, G.S.W.A. Bull. 27, p. 22, pl. V, figs 1-3, and Bull. 58, p. 36, pl. VIII, fig 1, show the margin of the anterior ear with the same outline as that of the Wooramel specimens, see pl. XI, fig. 4.

The larger specimens in the present collection bear a very striking likeness in ornamentation and general outline to a coarsely ribbed shell figured

*1847 McCoy Ann. and Mag. Nat. Hist. XX., p. 298, pl. XVII., fig. 1.

1906 Eth. jun. and W. S. Dun, Geol. Survey of N.S.W. Pal. Mem. 5, Vol. II., pt. I., p. 26, pl.

III., fig. 2, pl. IX., figs. 1-5, pl. XII., figs. 2 and 3, pl. XIII., figs. 2 and 8, pl. XIV., fig. 1.

1929 H. O. Fletcher, Rec. Aust. Mus. Vol. XVII., No. 1, p. 30, pl. XV.

† I have not seen that given by Etheridge, Proc. Roy. Phys. Soc. Edin. 1880, V., p. 297, pl. 13, fig. 52.

by Fletcher under the name *D. comptus* Dana. Fletcher's fig. 1 shows the outer margin of the anterior ear rounded, whereas in the Wooramel specimens the anterior margin of the ear meets the dorsal margin at a blunted angle, varying from an acute to almost a right angle. As the growth lines on Fletcher's specimen show exactly the same curvature as those on the Wooramel specimens, where the outer margin is parallel to the growth lines, it seems likely that the margin of Fletcher's specimen is imperfect. Fletcher states that the posterior ear is larger than the anterior. This is scarcely shown by the figure unless the indefinite shaded area is all ear. The shape outlined by the heavy growth line is the same as that outlined by growth lines and margin on the W.A. specimens.

Fletcher also says the anterior ear shows primary and secondary ribs, whereas the posterior shows equal ribbing. On the Western Australian specimens the ribbing on the ears is variable; some show a few ribs on the anterior ear stronger than others as on Fletcher's specimens; others show equal fine ribbing. The ribbing is stronger on the anterior ear than on the posterior, hence it is preserved on the anterior when that on the posterior has been worn off.

On the whole, I can find no definite means of distinguishing the Wooramel specimens, either from *D. subquinclineatus* McCoy or from *D. comptus* Dana. Dana's species had been included by Etheridge & Dun, Mem. G.S. of N.S.W. Palaeontology, No. 5, ii., I., 1906, p. 26, as a synonym of *D. subquinclineatus*, but Fletcher says of his specimen: "This is a definite coarsely ribbed form and so unlike *D. subquinclineatus* that I have no hesitation in re-establishing Dana's specimens." Later he says: "its ornamentation definitely separates it from *D. subquinclineatus*," i.e., he excludes coarsely ribbed forms from the species *subquinclineatus*. There are two objections to this. Firstly, McCoy's original *D. subquinclineatus* is by no means finely ornamented. He describes the primary ribs as "rather coarse narrow rounded ridges" and his figure gives the impression of a fairly coarse ornamentation, certainly coarser than that figured by later writers as this species (e.g. Eth. jun. Pal. Mem. G.S. of N.S.W., No. 5, Vol. II., pt. I., pl. IX., figs. 1 and 2 or Fletcher, Records Australian Museum, XVII., No. 1, pl. XV., fig. 4). Secondly the suite of sixty specimens from the Wooramel exhibits all stages between a very coarsely ribbed form, such as Fletcher's *D. comptus* and one in which the primary ribs are only half this width at the same distance from the umbo and no coarser than those of McCoy's original figure. For these reasons I do not think the species *D. comptus* can stand as there are no other features distinguishing it from *D. subquinclineatus*. On the other hand, were a large number of specimens not available to show the gradual variation in coarseness of ornamentation, forms such as Fletcher's pl. XIII., fig. 1, and some of the Wooramel specimens would seem strikingly different from what is apparently taken by Etheridge & Fletcher as the typical *D. subquinclineatus*. Therefore, it seems advisable to distinguish the coarser ribbed forms as variety *comptus* of McCoy's species.

Previous records in W.A.—Fletcher, p. 25, records a specimen of *D. comptus* from east of Mingenew, W.A. In Geological Survey Bulletin 27, Etheridge described three limonitic casts from Mingenew under the name *D. subquinclineatus*. These, and another from Byro Station (Geol. Surv. Bull. 58) are exactly similar to the limonitic casts from Bogadi Outcamp and have, therefore, been included in the synonymy above.

Specimen Numbers: Geological Survey $\frac{1}{4697}$, $\frac{1}{4698}$, $\frac{1}{4699}$, $\frac{1}{4643}$, $\frac{1}{4648}$,
 $\frac{1}{4945}$ and $\frac{1}{4948}$.

Department of Geology, University, 8479, 8482,
8475 and 8476.

Genus PARALLELODON, de Koninck.

A fragment registered as 4682^1 Geological Survey is recognised as belonging to this genus from its likeness to specimens obtained from near Holmwood Station in the Irwin River District. The specimen comes from the south bank of the Wooramel R. below Callytharra Springs and is found with an assemblage of fossils typical of those occurring in the Irwin River Valley.

CLASS GASTROPODA.

Genus PTYCHOMPHALINA (Bayle) Fischer 1885.

(Man. Conchyl. et Pal. Conchyl. Fas. 9, 1885, p. 850).

Ptychomphalina maitlandi, R. Etheridge, junior.

1903 *P. maitlandi* Eth. jun. G.S.W.A. Bull. 10, p. 24, pl. I, figs. 13-15.

1914 " " " " " 58, p. 37.

The collection contains a number of specimens of this species, which is easily recognised by its stout conical form and the sutural position of the band on the posterior whorls.

Specimen Numbers: Geological Survey 4647^1 , 4648^1 , $?4696^1$, and 4959^1 .
Department of Geology, University, 8485, 8481.

CLASS PTEROPODA.

Genus CONULARIA Miller.

Conularia, cf *C. warthi* Waagen.

Plate XI., figs. 3-6.

1886 *C. cf irregularis* (Kon.) Waagen, Rec. Geol. Surv. Ind. Vol. XIX., p. 26, pl. 1, fig. 2 (non *C. irregularis* Koninck)

1889-91 *C. warthi* Waagen, Salt R. Foss. (Pal. Ind.) Vol. IV., p. 126, pl. IV., figs. 6a-d, pl. V., figs. 1a-b.

1912 *C. sp. nov.?* cf *C. warthi* (Waagen) Glauert, Rec. W.A. Museum, Vol. I., Pt. II., p. 76.

The present collection contains fragments identical with those from Byro Station described by Mr. Glauert, but includes also two much better specimens enabling me to add a little to his description. The specimens are elongated, conical pieces, one 45 mm. in length with an apical angle of 16° , the other 75 mm. in length with an apical angle of 20° . Both are rhombic in section with one diameter longer than the other. One specimen is considerably more compressed than the other, probably due to crushing. This would account for its greater apical angle. At each of the corners is a furrow and in the middle of each side a faint groove.

The ornamentation is of transverse ridges, ten or eleven in 10 mm., becoming more crowded towards the apex. The ribs bend up slightly as they descend into the side furrows and alternate on either side of the furrow. They ascend to the middle of each side where they may alternate or merely be interrupted at the middle groove. The crests of the ribs are ornamented by fine granulations. In *Conularia warthi* the granulations are connected by fine irregular plications extending across the spaces between the ribs.

Neither specimen is well enough preserved to show the shell in the spaces between the ribs. On one portion where a little shelly material is preserved the plications may be seen descending the sides of the ridges so that it may well be supposed that they are continuous across the valleys between ridges.

Conularia warthi is further characterised by the presence of a row of intercostal tubercles on each side of the lateral furrows. Their presence cannot be ascertained on either of these specimens owing to their imperfect preservation.

The only definite character in which these differ from *C. warthi* is the greater apical angle, 16° — 20° as opposed to 12° in *C. warthi*.

Specimen Numbers : Geological Survey 4645^1 , 4695^1 .
Department of Geology, University 8478.

EXPLANATION OF PLATES.

PLATE III.

All figures are natural size, unless stated otherwise.

- Fig. 1.—*Clisiophyllum talboti*, n. sp.—1a. Geol. Survey Specimen 4962^1 .
1b. Same specimen looking down into calyx. Secondary septa seen at top and right of figure.
- Fig. 2. ,, ,, ,, Weathered specimen showing twisting of septa on false columella.
- Fig. 3. ,, ,, ,, Geol. Survey Specimen 4660^1 .
(a) side view, (b) dorsal view,
(c) showing oval cross section, rudimentary septa shown on right side of figure.
- Figs. 4–6.—*Pterophyllum australe*, Hinde, showing longitudinal and transverse ornamentation.
- Fig. 7.—*Aulosteges spinosus*, n. sp., ventral valve.
7a, dorsal view ; 7b, ventral view ;
7c, side view ; 7d, outline drawing from 7c enlarged four diameters to show pseudodeltidium and upturned cardinal margin.

PLATE IV.

- Fig. 1.—*Streblotrypa marmionensis*, Eth. jun., microphotograph of portion of zoarium (x20).
- Fig. 2.—*Rhombopora multigranulata*, Bretnall, do. do.
- Fig. 3.—*Fenestella horologia*, Bretnall do. do.
- Fig. 4.—*Aetomacladia ambrosoides*, Bretnall, microphotograph of portion of zoarium at intersection of one of cross branches (x20).
- Fig. 5.—*Coscinum* ? Microphotograph of portion of zoarium (x20).

PLATE IX.

All figures are natural size.

- Fig. 1a.—*Spirifer rostralinus* var. *crassus*, n. sp. and var.—Same specimen as plate VI., fig. 2, tilted slightly backwards to show semi-circular margin.
- Fig. 1b.— „ „ „ Dorsal view of same specimen.
- Fig. 1c.— „ „ „ Posterior view of same specimen.
- Fig. 1d.— „ „ „ Anterior view of same specimen.

PLATE X.

All figures are natural size.

- Figs. 1a-c.—*Spirifer rostralinus* var. *auritus*, n. sp. and var.—Cast Department of Geology, specimen 8505, Byro Station. 1a, ventral valve; 1b, dorsal valve; 1c, anterior view.

PLATE XI.

All figures are natural size.

- Figs 1 & 2.—*Spirifer rostralinus* var. *crassus*, n. sp. and var.—Casts Department of Geology Specimens 8477. Compare Geol. Survey Bull. 58, pl. III, figs. 2 and 3, plate V, figs. 3 and 4.
- Fig. 3.—*Conularia* cf. *C. warthi*, Waagen. Impression showing ornamentation, Geol. Dept., Specimen 8478.
- Figs. 4 & 5 „ „ „ Two views of Geological Survey specimen $\overline{4645}^1$.
- Fig. 6 „ „ „ Geol. Survey specimen $\overline{4695}^1$, slightly crushed.

PLATE XII.

All figures are natural size.

- Fig. 1.—*Dellopecten subquiquelineatus*, McCoy, var. *comptus*, Dana. Geol. Survey Specimen $\overline{4643}^1$. Left valve showing posterior ear.
- Fig. 2. „ „ „ var. *comptus*, Dana. Department of Geology, specimen 8482. Left valve showing anterior ear.
(unbo repaired in plasticine.)
- Fig. 3 „ „ „ var. *comptus*, Dana.
Portion of right valve of specimen $\overline{4643}^1$
(which is seen over top of left valve in fig. 1) showing flat posterior ear.

PLATE XIII.

All figures are natural size.

Fig. 1.—*Deltopecten subquiquelineatus*, McCoy, var. *comptus*, Dana.

Right valve of small specimen 8482, Department of Geology, showing simple ornamentation, slight slope to posterior ear and byssal sinus at junction of anterior ear.

Fig. 2 ,, ,, ,, var. *comptus* Dana.

Small right valve, Geol. Survey specimen $\frac{1}{4948}$, showing shape and ornamentation of anterior ear.

Fig. 3 ,, ,, ,, var. *comptus* Dana.

Department of Geology Specimen 8482. Left valve showing simpler ribbing than Plate X, figs. 1 and 2.

Fig. 4 ,, ,, ,, var. *comptus* Dana.

Department of Geology Specimen 8482. Left valve showing shape of umbo and ears, posterior one very slightly chipped.

Fig. 5 ,, ,, ,, var. *comptus* Dana.

View of hinge of combined valves of specimen figure Plate X, fig. 2. Shows broad hinge plates with semi-circular chondrophores.

Fig. 6.—*Deltopecten subquiquelineatus*, McCoy, var. *comptus* Dana.

Department of Geology Specimen 8476. Impression of right valve showing simple ribbing, anterior ear and byssal sinus. (Corrugated portion in position of posterior ear is a portion of a *Conularia*.) The ventral margin of the specimen dips steeply away from the observer, *i.e.*, specimen is convex, see unbroken line text fig. 5, but perspective is lost owing to dark colour of the specimen.

Plate III.

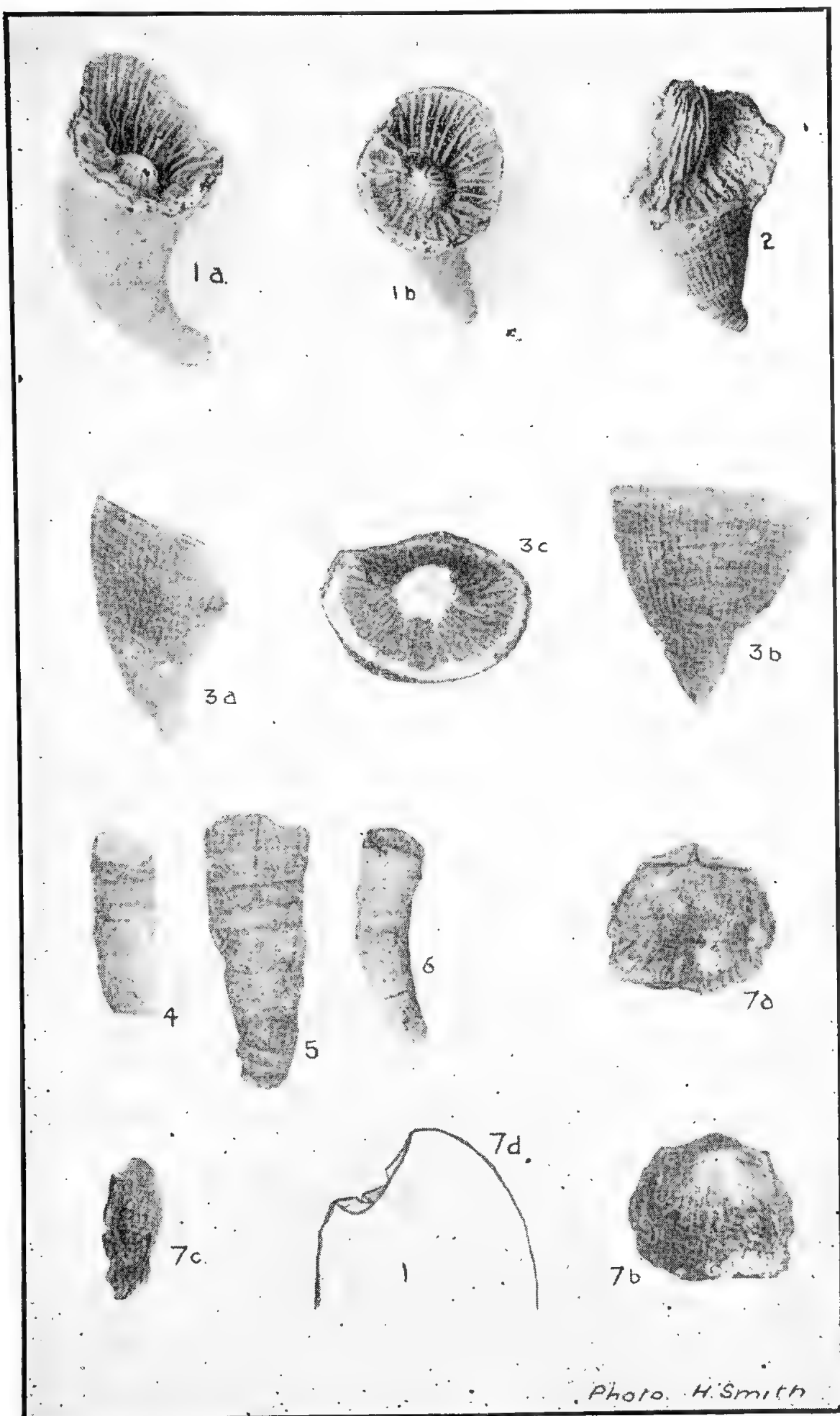


PLATE IV.

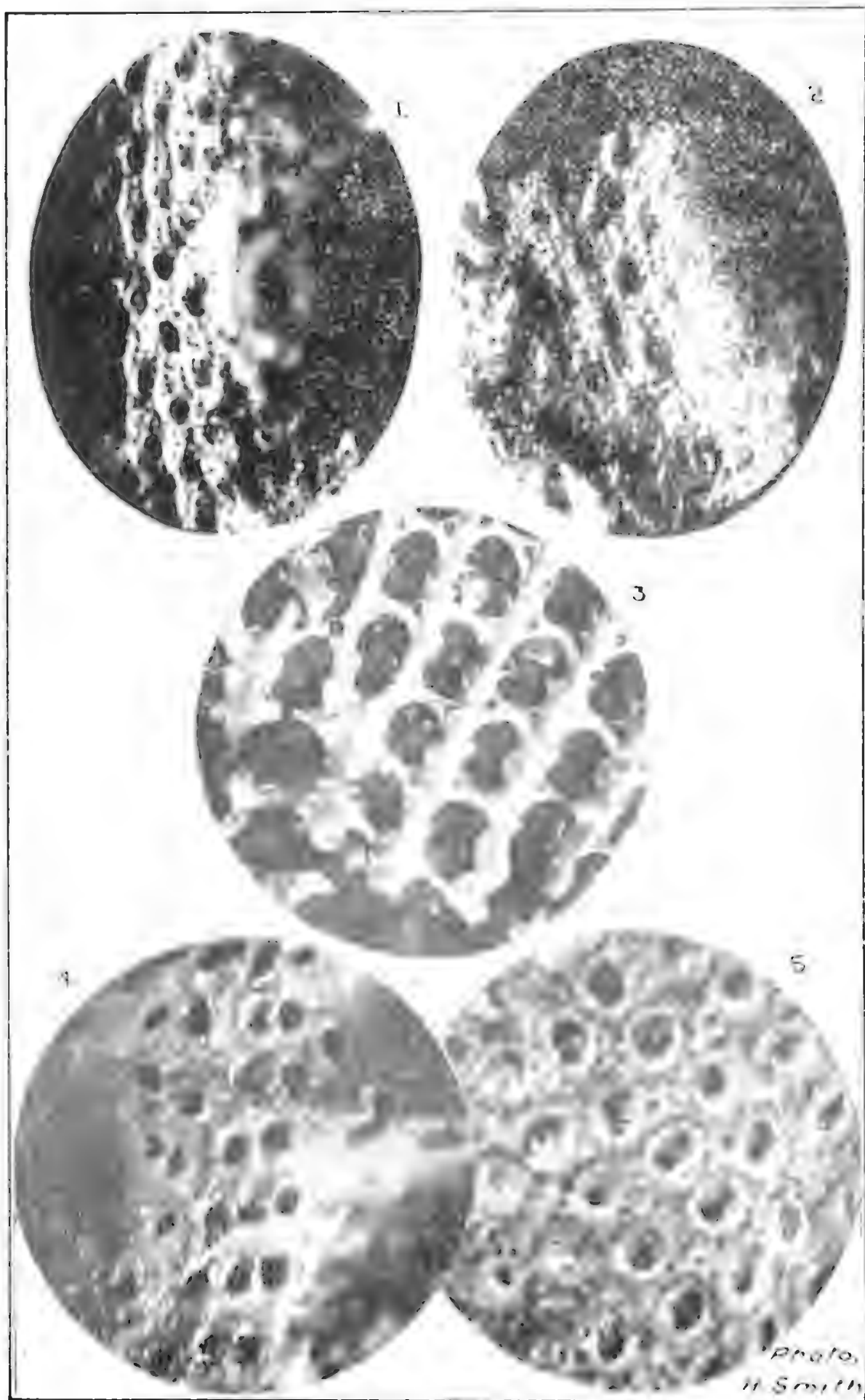


Plate V.

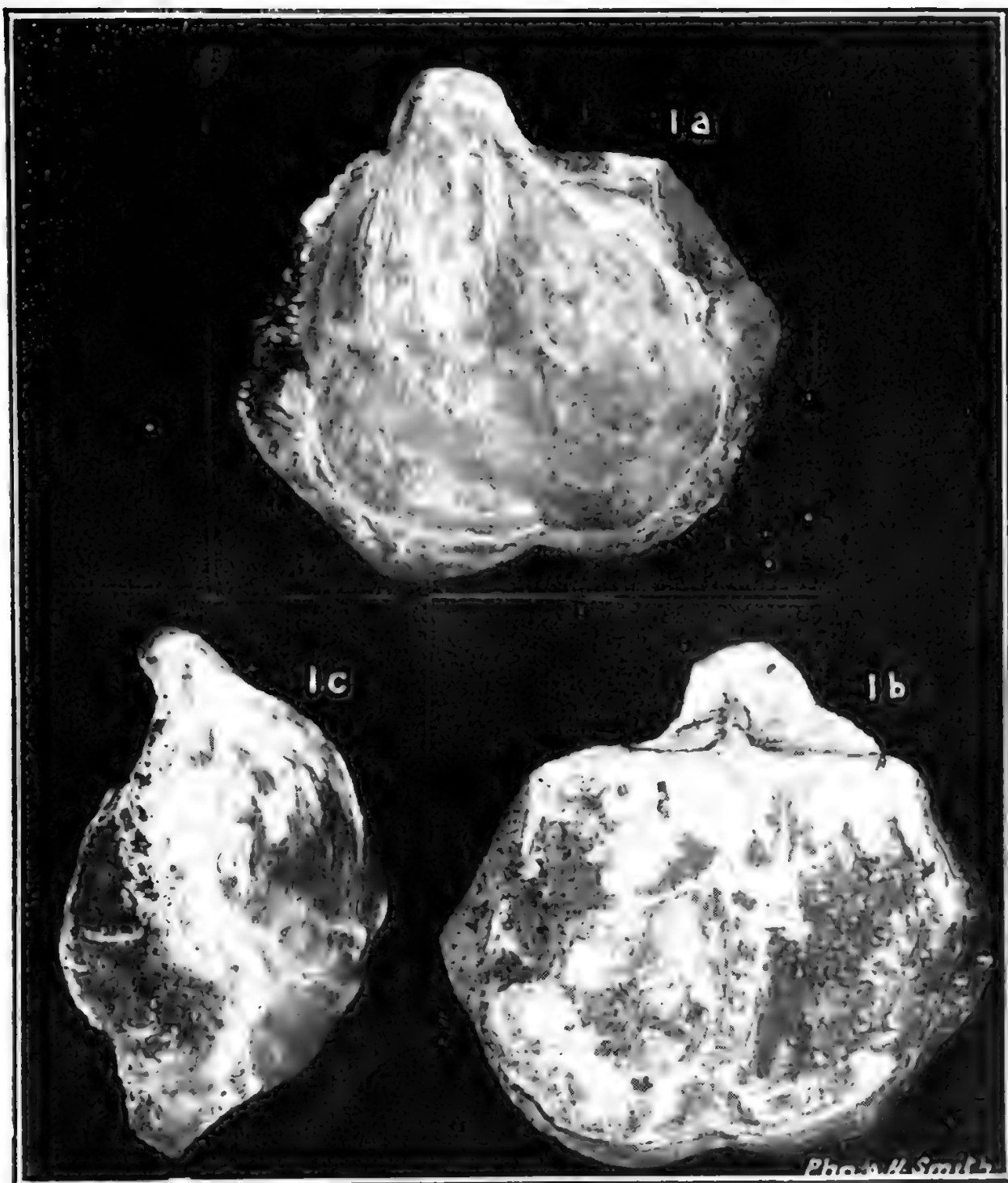


Plate VI.

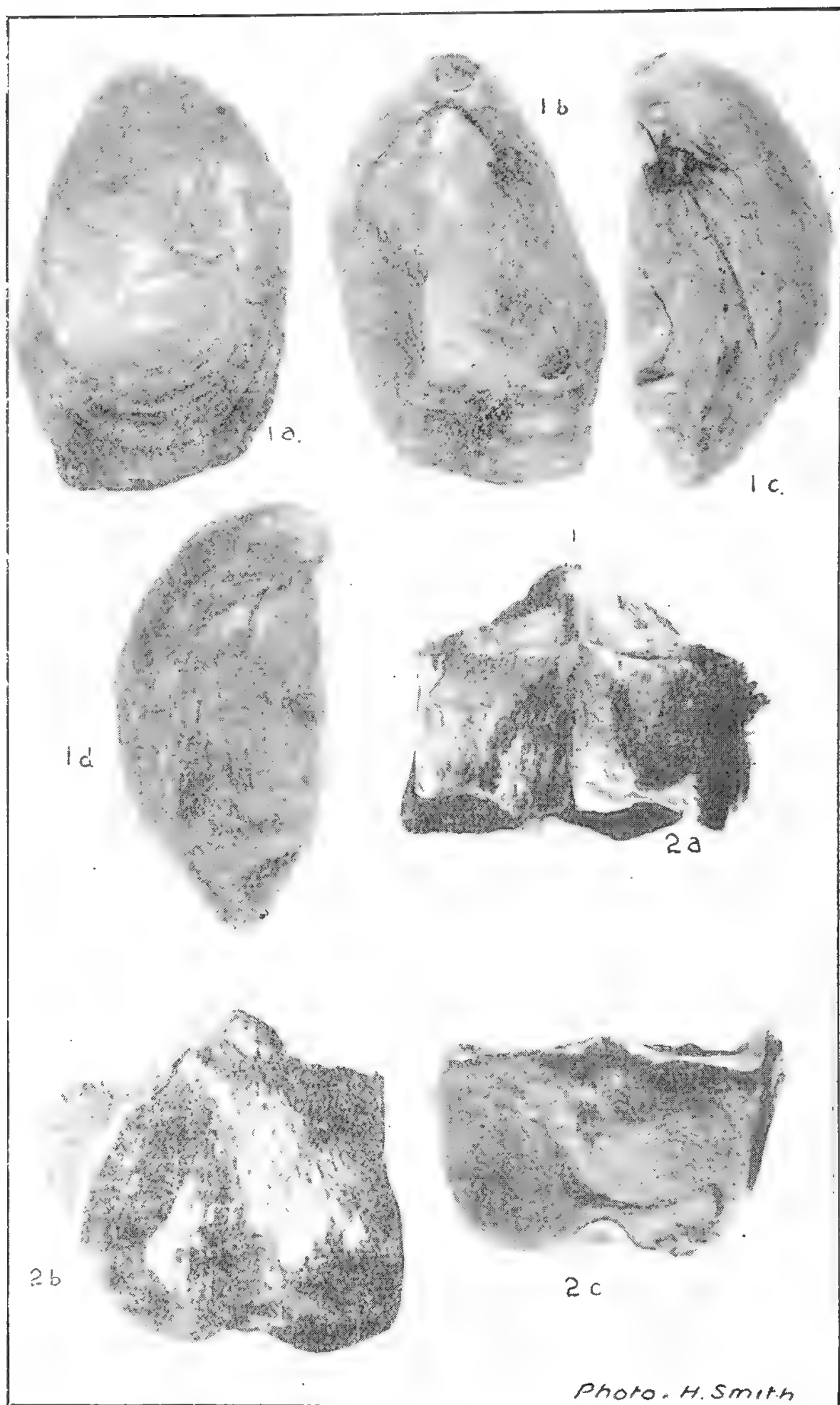
*Photo. H. Smith*

Plate VII.

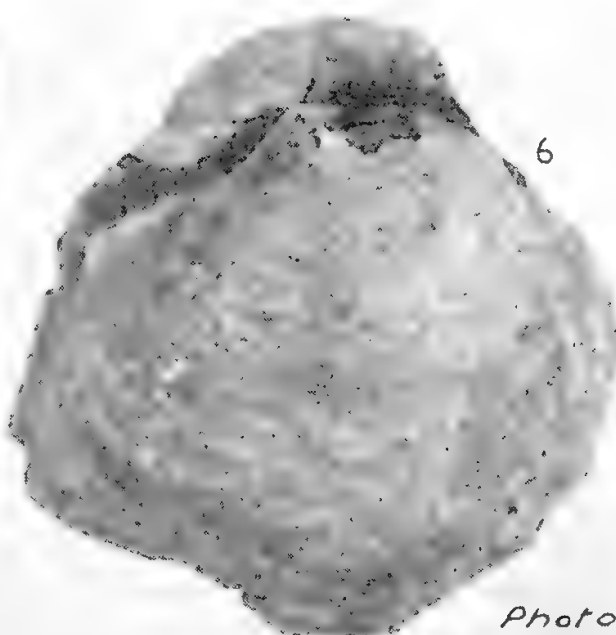
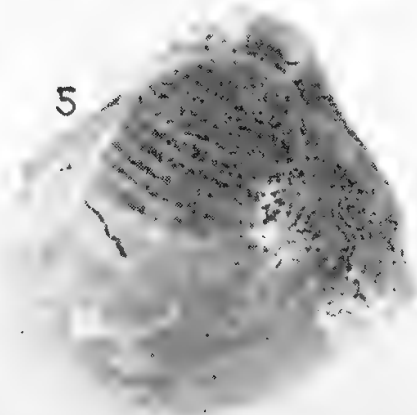
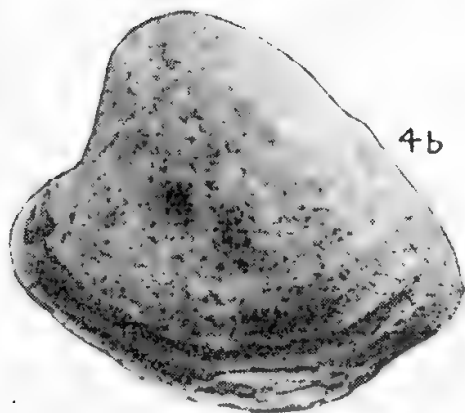
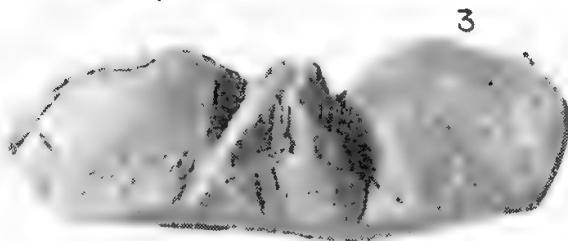
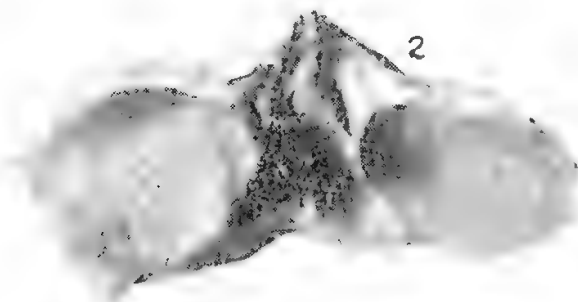
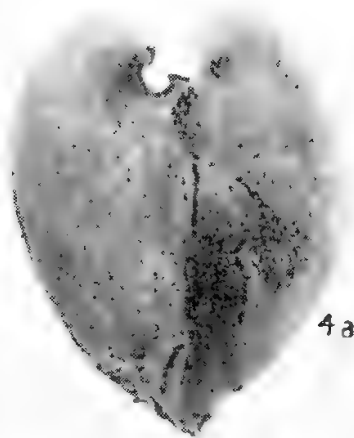
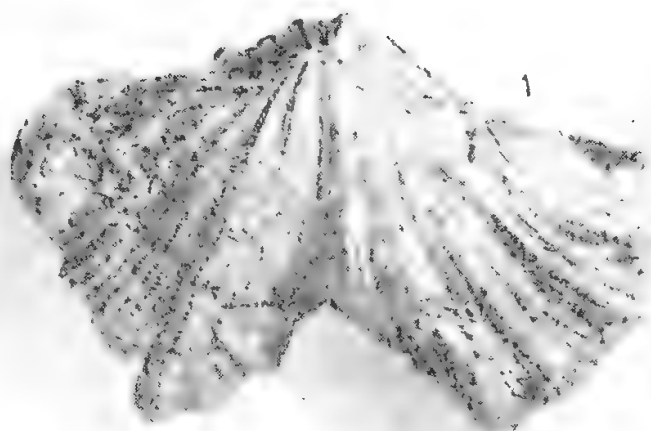


Photo.
H. Smith

Plate VIII.

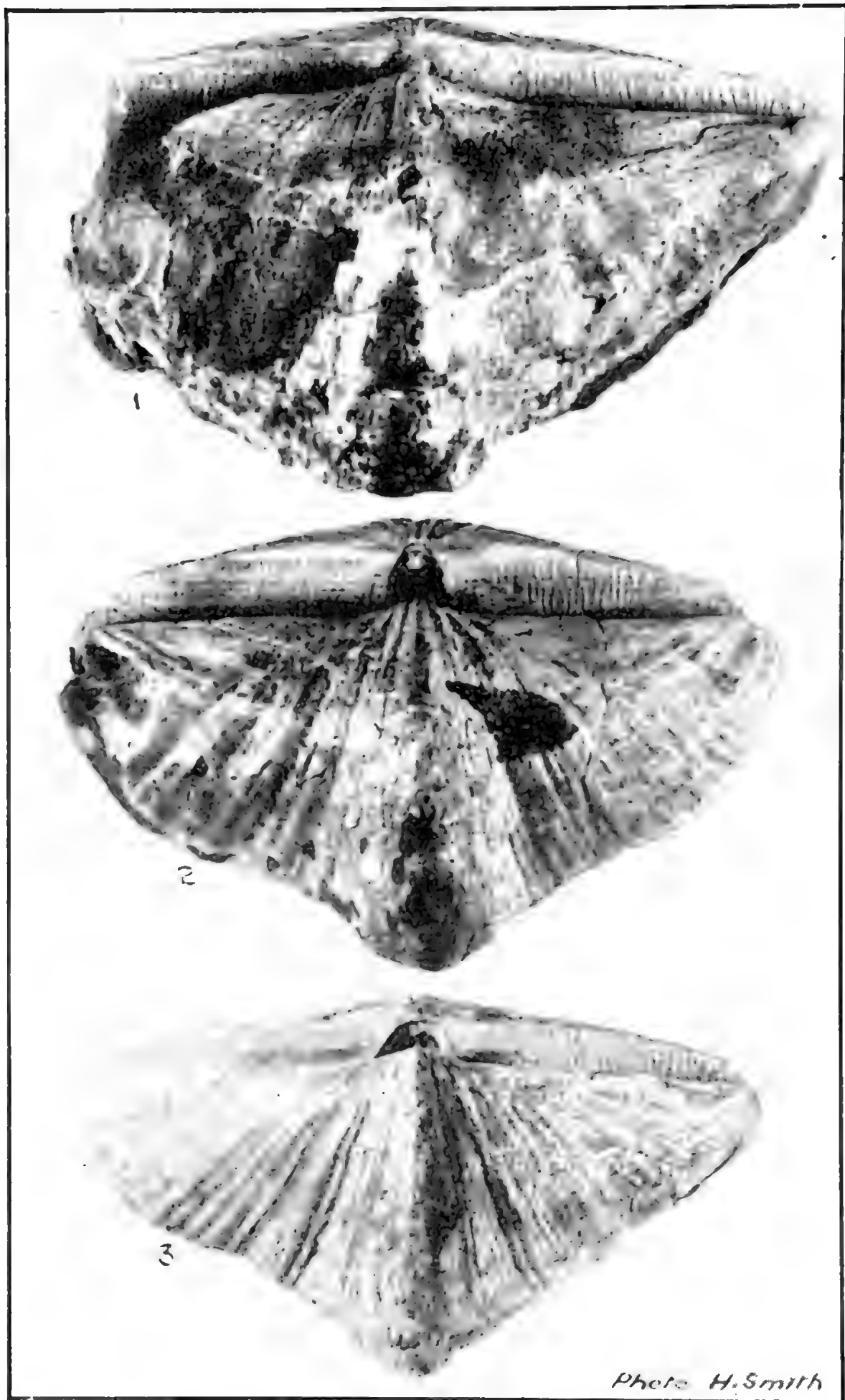


Plate VIIIa.

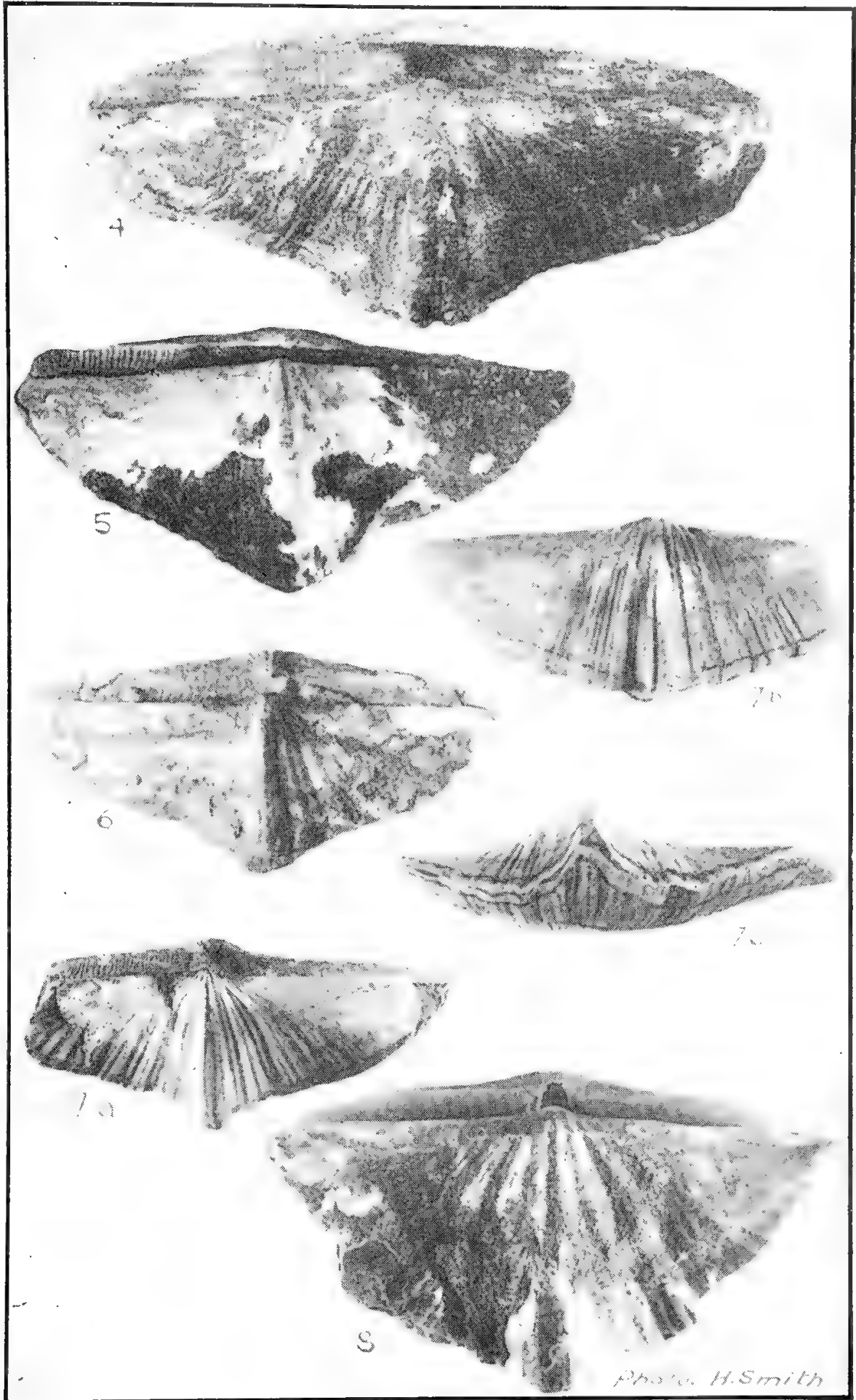


Plate IX.

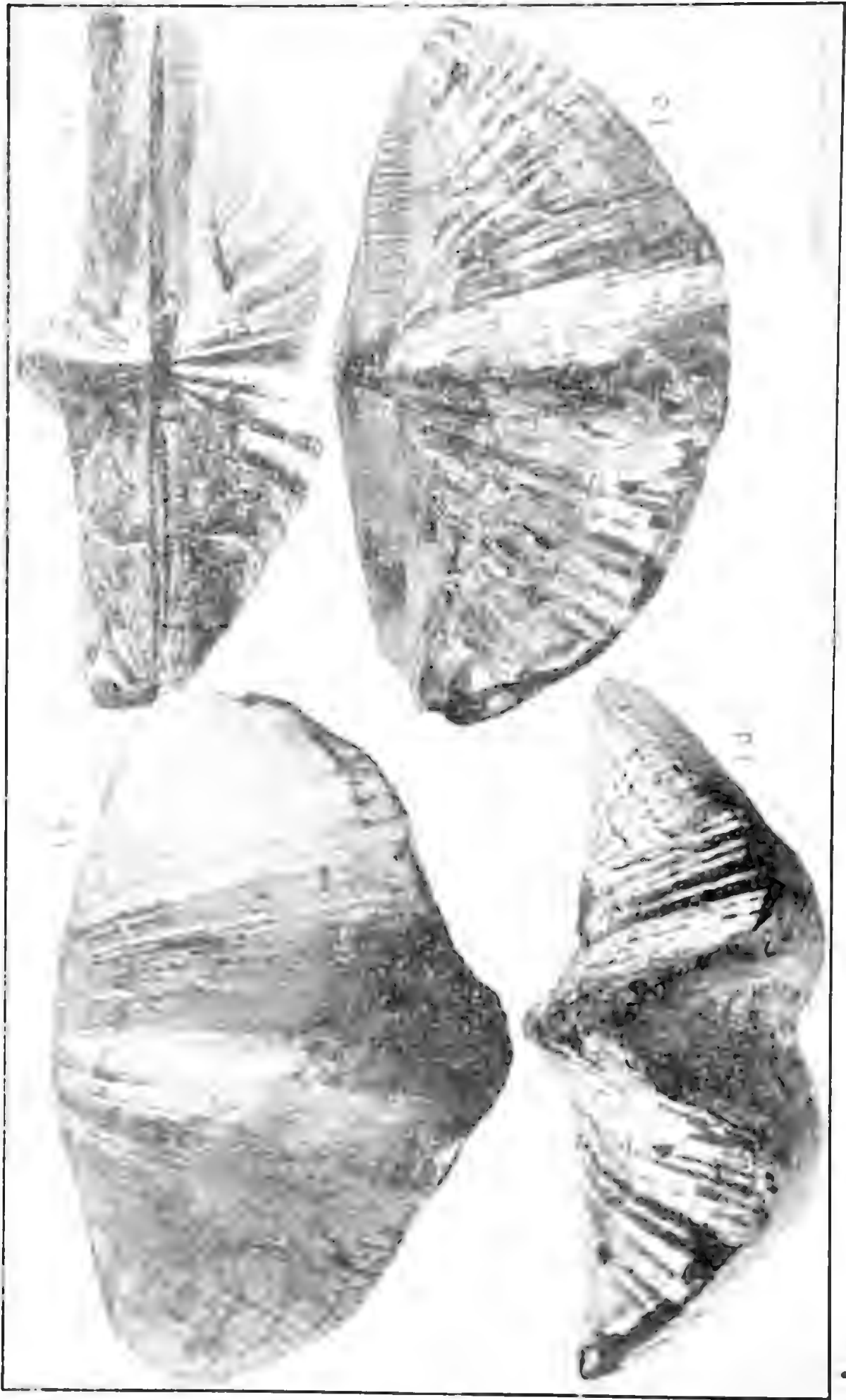


Plate X.

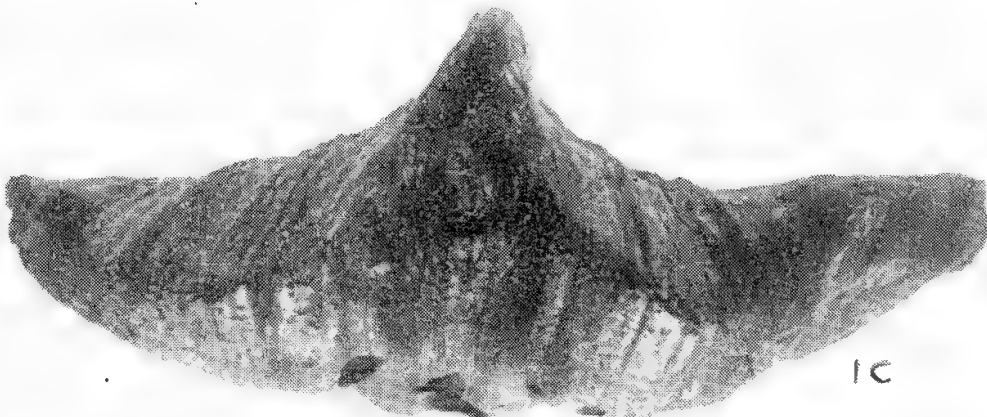
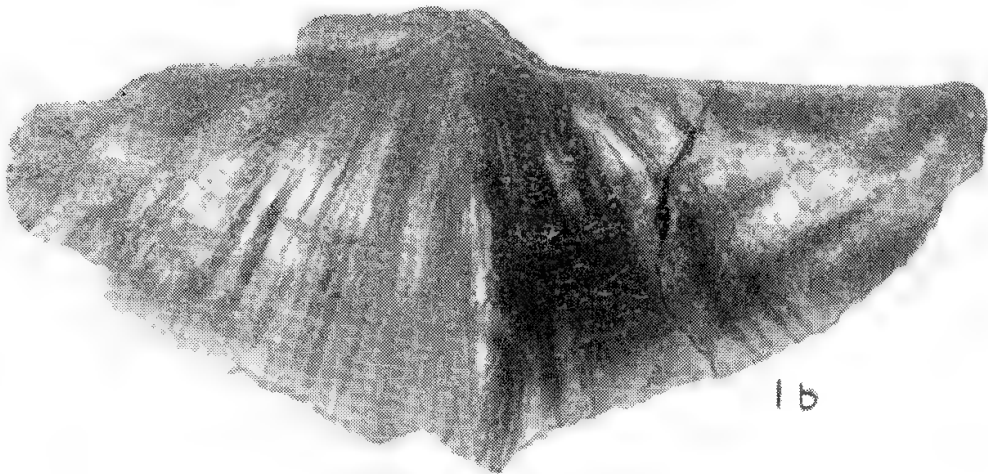
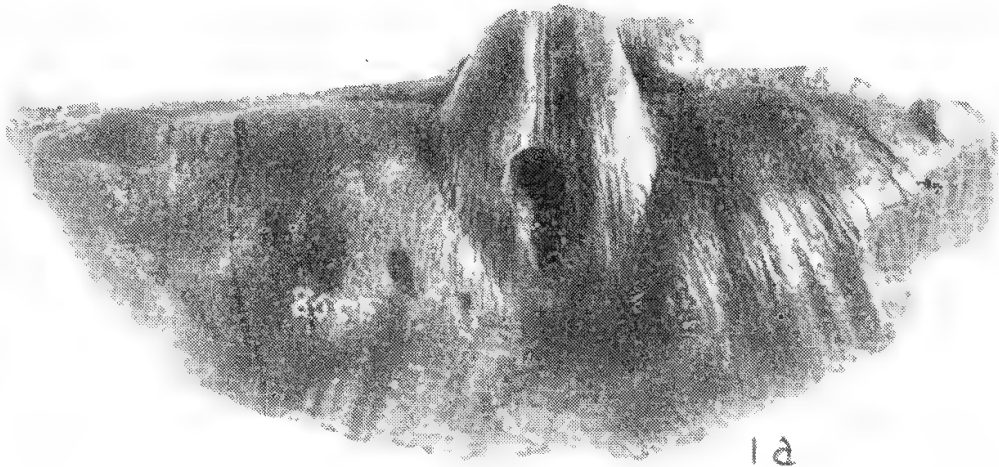


Plate XI.

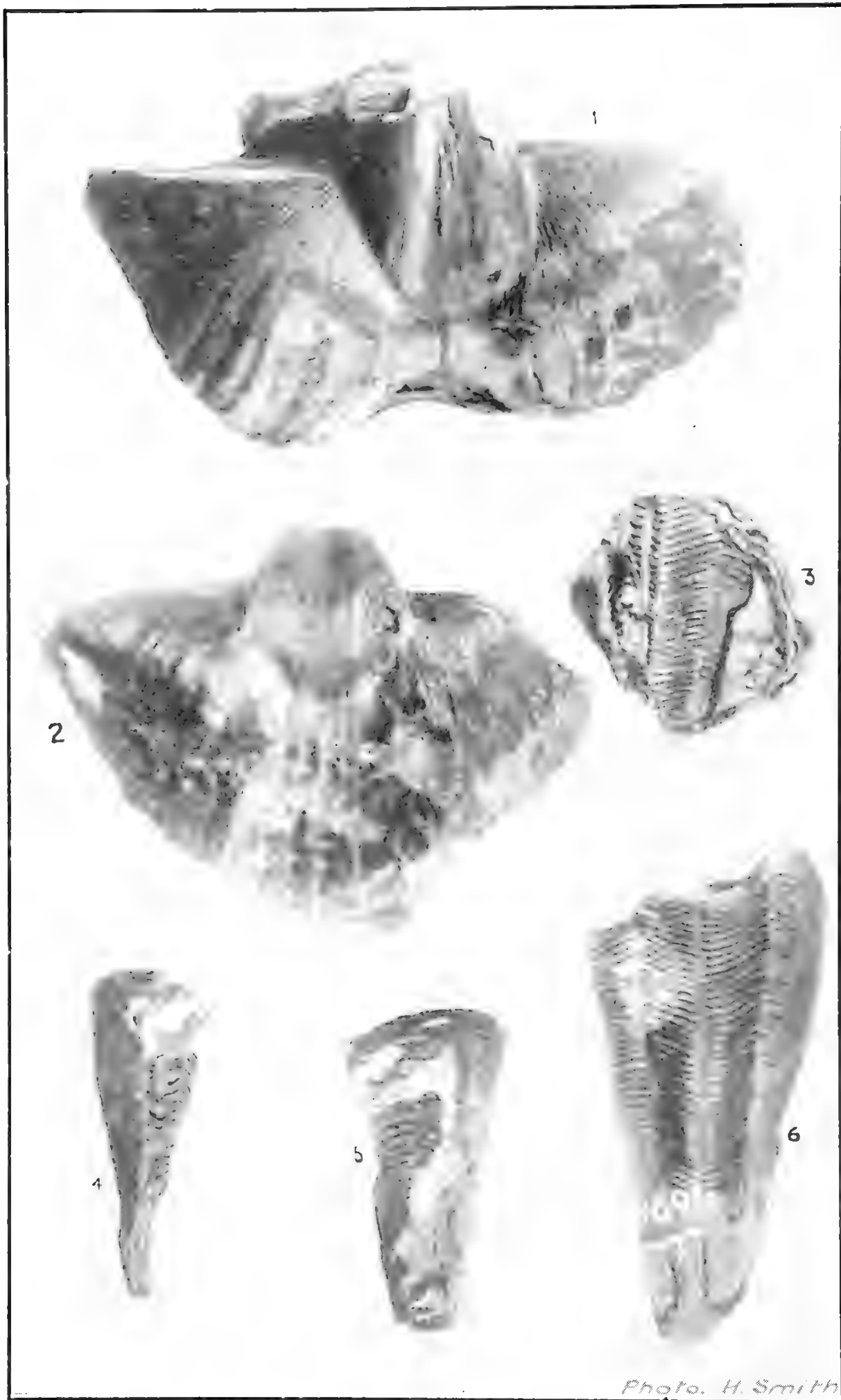
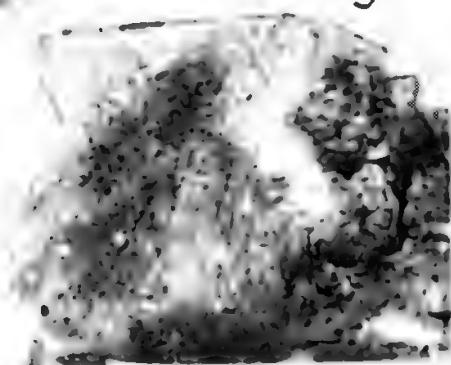
*Photo. H. Smith*

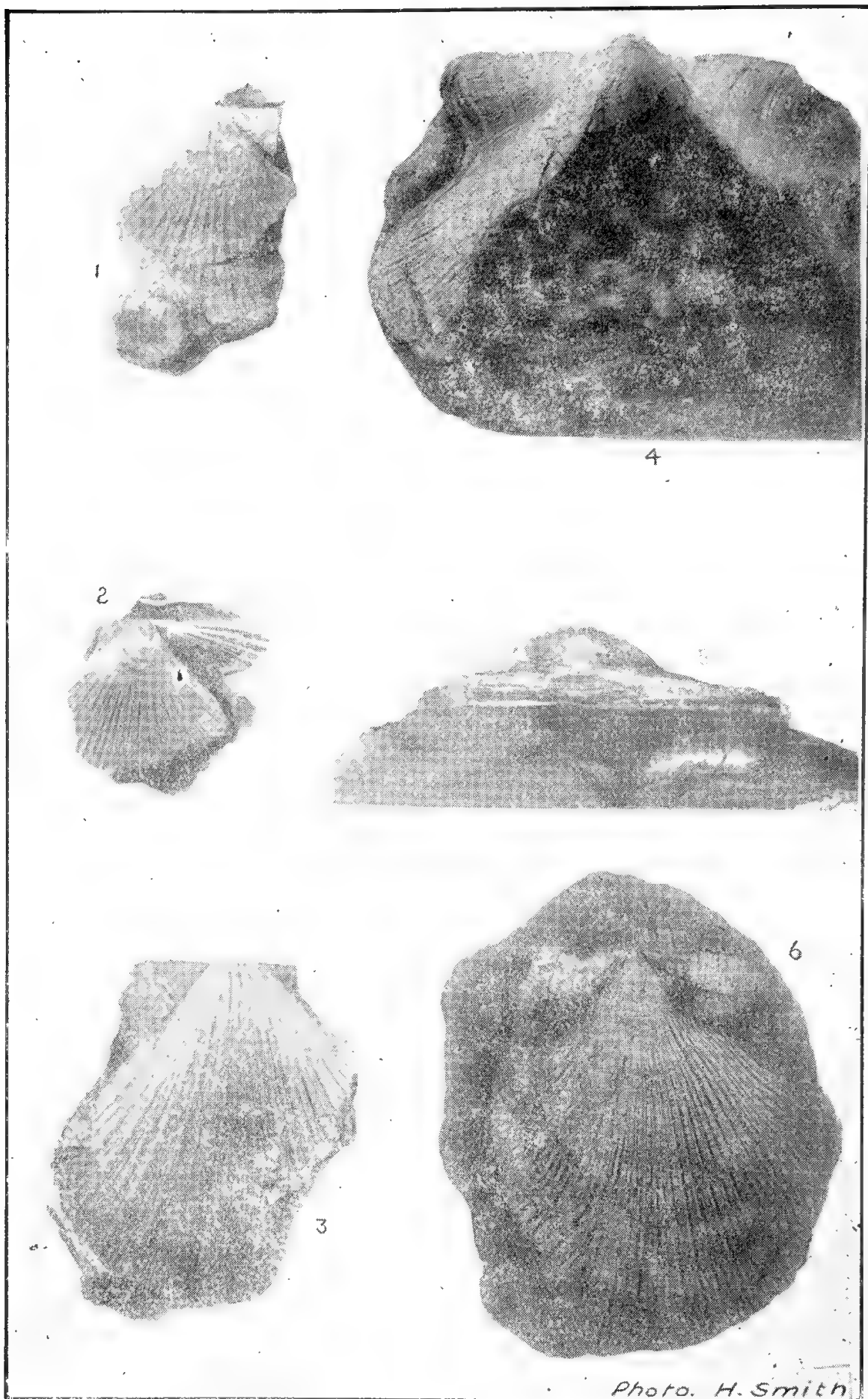
Plate XII.



2.

Photo. H Smith

Plate XIII.



3.—AN INTRODUCTION TO THE WORRORA LANGUAGE.

PART I.

BY J. R. B. LOVE, B.A., M.C., D.C.M.

Read 12th August, 1930, Published 13th May, 1931.

NOTE ON PRONUNCIATION.

This rendering of the Worrora grammar has been undertaken for the purpose of teaching the Worrora to read the Scriptures in their own tongue. Accordingly, a system of phonetics based on the use of diacritical marks has been deemed unsuitable. The following scheme has been adapted from the publication of the British and Foreign Bible Society : Bible House Paper No. V., Literation and Transliteration :—

Sounds in English.							Representa- tion.	Examples.
The sound of	a	as in	America	...	...	...	a	kaloomba
"	"	a	" far	...	...	...	a	kaloomba
"	"	a	" pat	...	...	...	a	alp
"	"	i	" pin	...	...	...	i	ingkorlu
"	"	i	" machine	...	...	...	i	iarung
"	"	u	" pull	...	...	...	u	wunia
"	"	u	" rule	...	...	...	u	wullunnu
"	"	u	where necessary	...	...	...	oo	woonya
"	"	e	as in let	...	...	...	e	ngenga
"	"	o	" lot	...	...	...	o	ngauona
"	"	o	" stone	...	...	...	o	o (= " but ")
"	"	ai	" aisle	...	...	...	ai	ngaiu
"	"	ou	" pout	...	...	...	au	kaua
"	"	{ a	" Mary	...	...	...	...
"	"	{ ai	" fairy	...	...	...	...
"	"	{ ea	" bear	...	...	...	eh	geh, kunninehri
"	"	oi	" boil	...	...	...	oi	moia
"	"	aw	" jaw	...	...	...	aw	wunaurmurum
"	"	k	" king	...	...	...	k	ingkorlu
"	"	g	" give	...	...	...	g	geh
"	"	ng	" Birmingham	...	...	...	ng	ngaiu
"	"	ch	" chase	...	...	...	ch	achu-nganoong
"	"	j	" jar	...	...	...	j	inja
"	"	ny	" onion	...	...	...	ny	nunya
"	"	t	" Tartar	...	...	...	t	tai
"	"	d	" drum	...	...	...	d	darawa
"	"	n	" no	...	...	...	n	wunia
"	"	p	" par	...	...	...	p	pai
"	"	b	" bird	...	...	...	b	benallu
"	"	m	" map	...	...	...	m	murdu
"	"	y	" yard	...	...	...	y	nyina
"	"	r	" rug	...	...	...	r	iarung
"	"	l	" lamp	...	...	...	l	chena/ya
"	"	w	" will	...	...	...	w	wuna

Doubling of r indicates rolling of the letter, *e.g.*, ngarri.

A short vowel is indicated where necessary by doubling the following consonant.

Worrora is the language of the Worrora tribe of Australian aborigines who occupy the country between the Prince Regent and Glenelg rivers in North-Western Australia. The tribe numbers about three hundred persons.

To the North-East and North of the Worrora are the Wunambullu tribe, who occupy the country approximately to the Drysdale River. This tribe probably numbers about the same as the Worrora.

To the East and South-East of the Worrora are the Ngarrinyin, or Arkarrinyinja, tribe, who occupy the country adjacent to the Worrora in this direction, and whose Eastern boundaries I do not know. This tribe probably numbers about four hundred persons.

On the Montgomery Islands are a small tribe, the Yaujibaia. The Wunambullu speak their own proper language, which they call Wunambullu. In addition, all the adults of the Wunambullu speak Worrora.

The Ngarrinyin speak their own proper language which they call Wungarrinyinu. In addition, all the adults of the Ngarrinyin speak Worrora.

The Yaujibaia speak Worrora, which they have adopted as their own language. They are of a different physique, differ in having deep, guttural voices, and differ from the Worrora in having the tribal cicatrices much more heavily marked than the Worrora, yet they seem to be in process of absorption by the Worrora.

Thus the Worrora language is the peculiar property of a tiny number of people, less than four hundred ; and is spoken by perhaps one thousand people all told. Yet it is a distinct language, not properly to be called a dialect, for words common to this and neighbouring tribes, even words of a common root, are few.

Furthermore, it is a language that shows evidence of having reached a wonderful height of development, a most intricate and delicately constructed grammatical system, and, what is perhaps most surprising, a pronounced tendency towards euphony, which is attained by alliteration, rhythm, and even rhyme.

The Australian aboriginal is usually regarded as one of the most primitive types of man. To judge from the implements and objects of manufacture of the North-Western tribes, these tribes would seem to be at the most primitive stage of culture of the Australian tribes. Yet an examination of their language soon shows that the Worrora have reached a level of culture, in their mental outlook upon life, that must have evolved far beyond the beginnings of human speech. There is no sibilant in the Worrora language, nor, as far as I have learned, in any Australian language. This absence must constitute a weighty argument against the echoic theory that language originated in the imitation by man of the sounds of nature about him, for the hissing of the winds, of running waters, of the sounds of birds and insects, are perhaps the commonest sounds of nature, and the Worrora man cannot pronounce a sibilant.

In approaching the language I made a start by pointing to objects and getting men to give me the names of these objects. But it soon appeared that the names were not always quite the same. The solution came when, one day, a man appeared with the body of a freshly killed osprey. The bird had a bright, glittering eye. The man pointed to the bird's eye and said "Ombula." I pointed to my own eye and asked "Ombula" ? The man gave a negative shrug of one shoulder and said "Ngoon-gubula." I pointed to his eye and asked "Ngoon-gubula" ? He gave an affirmative movement

and said "Ngombula." Thus the secret of the differences that had puzzled me became apparent. The differences in names on different occasions were caused by pronominal affixes to the noun. So the first part of speech that must be seriously considered is the pronoun.

The first and second persons of the personal pronoun are simple, viz., ngaiu : "I," and ngoonju : "Thou."

When we come to the third person we find a number of different forms. "He" : inja means "he close at hand" ; inaw means "he at a distance, but within sight" ; irru means "he out of sight."

"She" presents the same inflexions. Nyina means "she close at hand" ; nyinaw means "she at a distance, but within sight" ; nyirru means "she out of sight."

There are two neuters, both meaning "it," viz., wuna and mana. These are discussed on page 63. They have the same locative endings as inja and nyina.

As well as the locative forms for the third person pronoun, there are the words aua : "he," nyungga : "she", kaua and maua : "it." These have no locative significance and are commonly used in narrative.

Number :

The Worrora have four number forms. Counting extends only to three. Indeed, exact counting extends only to two, the word for three meaning a small number, more than two, up to as many as might be shown by the fingers of one hand. The masculine forms of the numerals are : one, iarung ; two, iarungandu ; three or several, iarunguri ; many ardarawaia. (This last word is compounded from the pronoun arka : they, and the numeral neuter : darawa : many things.)

Throughout the pronoun and verb these four number forms extend, the singular implying one, the dual implying two, the trial implying three or several, and the plural implying many.

Interrogative, reflexive, emphatic and relative pronouns all are found. A negative pronoun also occurs, meaning "not I," "not thou," etc.

THE NOUN.

Names of parts of the body are inflected to denote person by means of pronominal prefixes. A list is given on page 64.

The possessive case is denoted by the addition of -nungga, etc., as with the pronoun.

The vocative is denoted by the addition of -i, with euphonic elision of final vowel. *E.g.*, Algoonya : "young man" ; Algoonyi : "Oh ! Young man !"

There are no other case inflexions.

Inflexion for the plural number is as follows :—

Nouns ending in -a form plural by changing -a into -aia. *E.g.*, chorlbudda : an orator ; chorlbuddaia : orators.

Nouns ending in -ya form plural by changing -ya into -ia, the i becoming accented. *E.g.*, chenalya : spear ; chenalia : spears.

Nouns ending in -ja form plural by changing -ja into -dia. *E.g.*, bunmunja : a medicine man (doctor) ; bunmundia : doctors.

These above examples are all of masculine nouns.

As well as modification of final vowel to denote plural, many nouns of the masculine and feminine genders duplicate the main syllable to denote

plural. *E.g.*, maba : old man ; mababaia : old men ; mabunya : old woman ; mababunya : old women.

Generic names are not plentiful, apart from the human family.

Man, woman, and child have a number of names corresponding to age.

Punaria includes all members of the animal kingdom on land.

Jaia includes fish and all animals of the sea.

Maia includes all vegetable food. Mungurria includes all food.

Nguwonu means "wood," and may be used to mean "tree," though the Worrora prefer to be definite and name the species of tree.

Among animals there is frequently a separate name for the male and female of the species. Where this is so, I know of only one instance where there is also a name for the species. This exception is worra : the "euro" (*macropus robustus*). Worra includes both genders : the masculine is arrura ; the feminine is worrinya.

Abstract nouns are difficult to determine. They do occur and appear to derive from verbs. Such nouns are neuter, of the wuna class. *E.g.*, Kungumiibu : "I show him" ; umiimbaieh : a sign. This is the neuter wuna passive form of the verb and means "it will be shown."

Grammatical Genders.

Among the humbler orders of the animal kingdom the grammatical gender frequently has no reference to the sex of the animal.

E.g., wonggurinya : "the crow," is feminine, whether applied to a male or female bird. Ngununya : "the corella cockatoo," is similarly feminine. So also nyinnyina : "the mosquito," is feminine. (This word is literally "she-she".) Taranm : the Banksian cockatoo, is a neuter noun.

The sun, murrungunya, is feminine, and is included among the totems of one local group as mother of that group.

The moon, koonyila, is masculine.

Spear, chenalya, is masculine, while the spear-thrower, yunggultya, is feminine ; a logical association of the spear that goes forth to kill with the companion that assists.

Most objects of masculine use and manufacture are masculine.

Particularly interesting is the application of Worrora grammatical genders to objects of European introduction.

Axe, saw, knife, and all similar tools of the white man are masculine.

Glass is feminine. The reason for this puzzled me till one man informed that it was because glass shines like the sun, and so is feminine as the sun.

Ngeenya, the wild honey, is feminine, and so the white man's jam, treacle, sugar, and all sweet things are feminine.

Flour, the most coveted of all the white man's foods, is masculine.

Watermelon is masculine ; but pumpkin is neuter, a good indication of the relative estimation in which the Worrora hold the two vegetables.

But, contrary to this system of logic, the Worrora men insist on calling a rifle neuter. I argued that, if the spear is masculine, because it goes forth to kill, much more so must the rifle be masculine. They agreed with a laugh that the argument was sound ; but, when I asked, "Now, what is rifle ?" all at once replied, "Wuna" (neuter : "it").

Amusing too is their estimate of tobacco. The strong twist tobacco supplied to the natives is highly esteemed and so classed as inja : "he." The milder, cut tobacco, which we whites smoke, is classed as nyina : "she" ; so the feminine connotes mildness. But, when I asked the gender of a cigar, I got an emphatic "Iuja !", "he" indeed !

THE ADJECTIVE.

The adjective follows the noun and is inflected to agree with the noun in person, gender, and number.

<i>E.g. :</i>	Ngania	....	....	I good ;
	ngunia	....	....	thou good ;
	inia	....	....	he good ;
	nyinia	....	....	she good ;
	wunia	....	....	it (wuna) good ;
	manium	....	....	it (mana) good.
	Nganaiuru	....	....	I great ;
	ngunaiuru	....	....	thou great,
	inaiiri	....	....	he great,
	nyinaiija	....	....	she great,
	wunaiiru	....	....	it (wuna) great,
	manaiudb	....	....	it (mana) great,
	ardenaiiri	....	....	they great.

The numeral adjectives are three, and agree with their noun in gender, viz. :—

Masc. ....	....	One : iarung, two : iarungandu, three : iarunguri.
Fem. ....	....	One : njarung, two : njarungandinya, three : njarungurinya.
Neut. wuna ....	....	One : charung, two : charungandu, three : charunguri.
Neut. mana ....	....	One : maiarungum, two : maiarungandum, three : maiarungurim.

Comparison of the Adjective.

Comparison may be expressed between two objects by adding to the adjective the word *ban*, or *man* (according to euphony) followed by *dugga*, meaning “from him,” or *duggaia*, meaning “from them.”

E.g. : “Koombaiu is a better man than Punauera,”

Koombaiu ija inia man dugga Punauera.

“Koombaiu is a bigger man than Punauera,”

Koombaiu ija inaiid ban dugga Punauera.

(Inaiid is a contraction of inaiiri.)

Man, following a vowel, or *ban*, following a consonant, is practically equivalent to “than.”

Superlative may be expressed by the word *jenbenguru*, meaning “very,” or by the addition of the duplicated word *ngurra-ngurra*.

Ngurra means “belonging to” or “pertaining to.” *E.g.*, *jaia ngurra* is a fisherman ; *worndu' ngurra* (*worndum ngurra*) is a seaman ; so a “very good man” may be expressed : *ija (man), inia ngurra-ngurra*.

THE PREPOSITION.

The part of speech which we name the preposition in English, follows the noun in Worrora.

(To retain the English name for convenience) the prepositions are few in number.

Nunya means “at,” “in,” “on,” “by,” “with,” also “by means of,” as applied to persons only.

Alp means “from,” applied to places.

Nyininggeh means "by means of," "with" (instrumental), as applied to inanimate objects only.

Nguru means "to," "towards," and implies motion away from the speaker.

E.g., Kabulba nunya : "on earth" ; worndum alp : "from the sea" ; kaiug nyininggeh : "by means of a stone" ; tambiu' nguru (tambium nguru) "to the place."

THE CONJUNCTION.

"And" is expressed by geh, which is either a conjunction or a relative pronoun.

"But" is O. *E.g.* : "I asked him, but he did not come,"

Burkai kungaiabuna, O wa punggenggunyal.

A copulative, used in enumerating lists of objects or persons, is ah. The Worrora frequently utter this sound, but perhaps it is not regarded as properly a word at all, but merely serves to bridge the hiatus between one object and the next ; as they do not seem to quite like its being repeated.

E.g. : "Fish and dugong and stingray,"
jaia ah bulguja ah ngubunu.

THE ADVERB.

Adverbs are numerous.

The adverb precedes the verb.

E.g. : "tightly" : punjuk ; "Hold it tightly" : Punjuk ima.
"ma" ; "there" ; "Sit there" : Ma achubunnu.

THE INTERJECTION.

Ai : "Hullo !", "Ho there !", used to attract attention.

Wai : "Lo !", "Behold !".

Rokai : expresses pity or commiseration.

Murai : expresses astonishment.

Miah : "Well now !", "Now then !".

Wau : used in admonition or reproof.

THE VERB.

By far the most important and highly developed part of speech in Worrora is the verb.

I have worked out four hundred and forty-four forms of the verb "to be." Counting participial forms separately this number would be almost doubled. The transitive verb "kill," which is the base of a large number of transitive verbs, has yielded over thirteen hundred forms.

There are the four number forms, singular, dual, trial, and plural, to be used in every mood and tense.

Pronominal affixes denote subject, and in the case of a transitive verb, object. These pronominal affixes denote which of the six personal forms (first person, second person, third masculine, third feminine, third neuter, wuna or mana), and which of the four numbers, is predicated.

In the indicative mood there is a different form for the positive and negative of each person and number.

There are few auxiliaries to the verb. Most of the changes in thought that, in English, are expressed by auxiliaries, are expressed in Worrora by different moods of the verb.

There is no separate mood form for the infinitive. This may be expressed by the addition of Woonya: "to," or "for the purpose of."

The imperative mood occurs in all persons, "let me do.....," "do thou.....," "let him, her, or it do....."

The subjunctive mood is used in hypothetical and dependent clauses.

The potential mood expresses "can" or "might."

The obligatory mood expresses "must."

The verb "to be" has passive forms that mean "to become" or "to happen."

A number of verbs consist of the verb "to be" in conjunction with an adjective.

A large number of verbs are based on the verb "kill" or "strike" (same word).

Another class of verbs is of those based on the verb "go."

A class of deponent verbs, of passive form, but intransitive meaning, occurs, *e.g.*, Ngawelgengu: I stand, is of the passive form. Cf. ngauingu: I am killed.

Amid all this vast system of inflexion a child of two begins to chatter to its parents. A clever boy of sixteen can go through a good many of the usual forms of a conjugation; but does not know them all. Any group of men of thirty years appear to be familiar with all the forms. To work out any conjugation, give the type word, *e.g.*, "kungaw": "I kill him"; tense, say, "Wehni": "now"; some key word that will give the required mood, say, "ngumba": "if" that will make the mood subjunctive; now name subject and object, and instantly all the men will answer with the required word, following out the verb through all desired numbers, tenses and moods.

Of course the Worrora have no formulated rules for grammar. Their speaking is wholly empirical. They have excellent rote memories. It seems to take about thirty years for a Worrora man to adequately master all his language.

Not infrequently it may happen that an elder of the tribe may be referred to for some uncommon word. Some of the old men are of little account in the tribe and show little intellectual ability. Others are men of much influence and keen intelligence.

THE PRONOUN.

Personal pronoun, nominative case, singular number.

First person	....	....	I	Ngaiu		
2nd person	....	....	Thou	Ngoonju		
3rd person (a)	....	....	He	Inja	Inaw	Irru
		....	She	Nyina	Nyinaw	Nyirru
		....	It (1)	Wuna	Wunaw	Wurru
		....	(2)	Mana	Manaw	Marru
3rd person (b)	....	....	He	Aua		
		....	She	Nyungga		
		....	It (1)	Kaua		
		....	(2)	Maua		

The forms as above, 3rd person (a), are locative forms.

Inja means "he" close at hand. Inaw means "he" at a distance, but within sight. Irru means "he" out of sight.

Similarly, nyina means "she" close at hand. Nyinaw means "she" at a distance, but within sight. Nyirru means "she" out of sight. So also wuna, wunaw, wurru; and mana, manaw, marru.

There are two neuters, wuna, with locative modifications, and mana, with locative modifications. Each of these words means "it"; but each represents a different class of noun.

The usages of wuna and mana are discussed on page 63.

The forms as above, 3rd person (b), are used without any locative implication, as a rule, and are common in narrative.

But locative modifications may occur even with these forms, *e.g.*, nyunggaw: "she over there," and auarru: "he-out-of-sight." These last forms are rarely heard.

Personal pronoun, nominative case, plural numbers.

Worrora has four number forms: *singular*, implying one; *dual*, implying two; *trial*, implying three or several; and *plural*, implying a large number.

Dual number.

First person	.... We two	(a) ngarendu
		(b) arendu
2nd person	.... You two	nyirendu
3rd person (a)	.... They two	(masc.) inggundu, inawyundu, irandu.
	,, ,,	(fem.) nyinggundinya, nyinawyundinya, nyirandinya.
	,, ,,	(neut. w.) wun-gundu, wunawyundu, wurandu.
	,, ,,	(neut. m.) man-gundum, manawyundum, marandum.
3rd person (b)	.... They two	(masc.) auandu.
	,, ,,	(fem.) nyunggandinya.
	,, ,,	(neut. w.) kauandu.
	,, ,,	(neut. m.) mauandum.

In first person, dual, trial and plural numbers, *the prefix of the nasal ng-* includes the person addressed. *The omission of this prefix excludes* the person addressed, *e.g.*, ngarendu means "you-and-I"; arendu means "some-other-person-and-I."

These inclusive and exclusive forms apply throughout the verb, as well as the pronoun.

In 3rd person the abbreviation w. signifies the wuna form of the pronoun; the abbreviation m. signifies the mana form of the pronoun.

The same abbreviations apply to the wuna and mana forms of the 3rd person in the verb, as well as the pronoun.

Trial number.

First person	.... We three	Ngaringguri.
	,, ,,	aringguri
2nd person	.... You three	Nyiringguri
3rd person (a)	.... They three	(masc.) ingguri
	,, ,,	(fem.) nyinggurinya
	,, ,,	(neut. w.) wun-guri
	,, ,,	(neut. m.) man-gurim.
3rd person (b)	.... They three	(masc.) auuri
	,, ,,	(fem.) nyunggurinya
	,, ,,	(neut. w.) kauuri
	,, ,,	(neut. m.) mauurim.

The locative modifications may be applied to the trial forms, *e.g.*, inawuri, irruri.

Plural number.

First person	.... We many	Ngarri
	.. ..	arri
2nd person	.... You many	nyiri
3rd person (masc. and fem.)	arka.	

The locative modifications are not applied to the plural forms implying many.

The third person plural arka includes masculine and feminine. Neuter nouns in third person, both wuna and mana classes, are represented by the singular forms for both pronouns and verbs. (c.f. the usage of Latin.)

The personal pronoun, possessive case.

The possessive case of the pronoun is denoted by the affix *-anungga*. This affix *-anungga* is applied to all numbers and persons of the pronoun, but—

- (1) Where the pronoun ends in a vowel the affix of possessive *-anungga* causes the elision of the final vowel of the pronoun, *e.g.*, “my,” *ngaiu-anungga*, becomes *ngaianungga*; “your,” *ngoonjanungga*, etc.
- (2) The possessive termination *-anungga* is further inflected to show the gender and number of things possessed, as follows:
 - Masc. object possessed, add *-anungga*.
 - Fem. object possessed, add *-anunggunya*.
 - Neut. wuna object possessed, add *-anungga*.
 - Neut. mana object possessed, add *-anunggum*.
 - For two masc. objects possessed, add *-anunggandu*.
 - fem. , *-anunggandinya*.
 - neut. wuna objects possessed, add *-anunggandu*.
 - neut. mana , *-anunggandum*.
 - For more than two masc. objects possessed add *-anunggaia*.
 - fem. , *-anunggaia*.
 - neut. wuna objects possessed, add *-anungga*.
 - neut. mana , *-anung-*
gaium.

E.g., My spear, *chenalya ngaianungga* (*chenalya* being a masculine noun).

My spear-thrower: *yunggulya ngaianunggunya* (*yunggulya* fem).

My stone: *kaiug ngaianungga* (*kaiug* neuter, wuna).

My house: *maiarum ngaianunggum* (*maiarum* neuter, mana).

Examples of dual and plural objects possessed:—

My two spears: *chenalya ngaianunggandu*.

My many spears: *chenalia ngaianunggaia*.

The plural possessives are as follow:—

First person Our (inclusive) *ngarkanungga*.

.. (exclusive) ... *arkanungga*.

2nd person - Your *nyirkanungga*.

3rd person, all genders *arkanungga*.

Where ambiguity might arise through similarity of second-person-exclusive and third-person forms, these are—

2nd-person-exclusive *ar-arkanungga*;

3rd-person *ark-arkanungga*.

The objective case of the pronoun does not occur alone. It appears as an affix to transitive verbs.

There are no other case inflexions.

The Interrogative Pronoun.

Who is he ? Ungguya ?

Who is she ? Unggunya ?

What is it ? (wuna) Unguja ?

„ „ (mana) Ungujum ?

Who are they ? Unggu-ungguya ?

The neuter wuna form is used, as in English, meaning either “ What is it ” ? or “ What do you want ” ?

Whose is it ? Ungguya anungga ? etc.

The Negative Pronoun.

Not I Ngaui.

Not thou Ngoonggi.

Not he Kauui. kani.

Not she Nyunggi, nyani.

Not it, wuna Kui, kani.

„ mana Maui. mani.

The forms kani, nyani, kani and mani, in third person, correspond to usage of inaw, etc., of personal pronoun.

E.g., “ Is Kanaway not there ? Not he,”

Kanaway kani ? Kauui.

Demonstrative ; reflexive, and emphatic ; relative.

Demonstrative :

(a) Singular (masc. only). This aia.

Plural (masc. only). These unja.

(b) Singular—This....masc....auch, fem....nyunggeh,....neut. w....kaueh,
neut. m....maueh.

Plural These....argeh.

Reflexive and emphatic.

“ Self ” is expressed by the addition of ngoonju-ngoongju.

E.g.— “ I myself ” : ngaiu ngoonju-ngoongju.

“ You yourself ” : ngoonju ngoonju-ngoongju.

“ He himself ” : aua ngoonju-ngoongju.

“ She herself ” : nyungga ngoonju-ngoongju.

“ They themselves ” : arka ngoonju-ngoongju.

The usage is the same for reflexive and emphatic, as in English.

E.g.— “ I cut myself ” : ngaiu ngoonju-ngoongju dir nganbuna.

“ I myself shall go ” : ngaiu ngoonju-ngoongju picha ngehyu.

Relative.

The word geh is either a relative pronoun, meaning “ that,” or a conjunction, meaning “ and.”

Other relatives are expressed by aua, nyungga, kaua, maua in singular ; auandu, etc., in dual ; arka in plurals for more than two.

Nouns in the first column are represented by the pronoun *wuna* ;

“ second “ “ “ mana.

The Worrora themselves are unable to give any rule for the distinction between nouns that must be represented by *wuna* and *mana* ; but they all, even young boys, unhesitatingly say to which class a noun must belong. Every verb has its pronominal affix for subject, and another affix for object, if the verb is transitive ; and the neuters must have their correct form, according to whether the noun is of the *wuna* or *mana* class. The class of every neuter noun must be known, to speak correctly.

I am unable to give the rule, or reason, for the difference between the nouns of the *wuna* class and of the *mana* class, and should be most pleased to learn of any suggestion that might help to an understanding of why there are two neuters.

The following remarks may throw some light on the usage: –

All nouns that end in the sounds -m, -ma, -b, -ba, -p, -pa are mana. In most cases the mana nouns seem to connote an idea of space or extent.

Mana may often be used to connote place, meaning “here.”

Wuna may similarly be used to connote time, meaning “to-day.”

But, the distinction would seem to depend, in some nouns at least, on the grammatical form of the word, and not of the concept behind the word. For, in the above listed two words for "ash," *benallu* and *pimbinulb* are exactly synonymous, yet *benallu* is *wuna*, while *pimbinulb* is *mana*.

The following two examples of Worrora application of their grammar to objects of European introduction are interesting in this respect :—

The Worrora word for “road” is *kaloomba*, a *mana* noun. Under primitive conditions a road is merely a track worn by generations of passing feet from camping place to favourite waters, game haunts, etc. But, of late years, the Worrora men have made a road for traffic from the shore of Port George IV. to the Kunmunya Mission. On this road the men have expended their labour and sweat of their brow. Along this road come the loads of flour, tobacco, and other goods, all of masculine gender in Worrora. So now the men tell me that *kaloomba* is not *mana*, but *inja*, *i.e.*, “he.” The neuter noun has become, through changed associations, masculine.

Again, the Worrora word for vegetable fibre string is *irkulya*, a masculine noun, represented by the pronoun *inja*. Sisal hemp was grown and used for making string. This string is also *inja*, *i.e.*, “he.” But when I asked the men the gender of hemp, at first they immediately said “*Inja*.” Then one man asked me the English name of the leaf. I replied “Hemp.” They repeated “*’Emp*, *’emp*, *Mana*.” At first they designated the hemp plant masculine, but, on hearing the sound of the English word, ending in -p, they declared that the noun is *mana*.

While I am quite unable to give an explanation of these two neuters, the following two examples will show what a great difference in the spoken language the two classes of neuter make.

“The boat comes” : *namundi koonyunggal*.

“The sea comes” (*i.e.*, “The tide is coming in”) : *worndum menggal*.

Koonyunggal means “it comes.” So also *menggal* means “it comes” ; but *namundi* : “boat,” is a neuter *wuna* noun and must take the *wuna* inflexion of the verb, while *worndum* : “sea,” is a neuter *mana* noun, and must take the *mana* inflexion of the verb.

The Noun.—Pronominal inflexion of names of parts of the body :—

English	...	The.	My.	Your.	His.	Her.
Head	...	<i>arbri</i>	<i>ngamri</i>	<i>ngumri</i>	<i>imri</i>	<i>nyimri</i>
hand	...	<i>ardori</i>	<i>nganori</i>	<i>ngunori</i>	<i>inori</i>	<i>nyinori</i>
foot	...	<i>arjerdu</i>	<i>ngaierdu</i>	<i>ngunjerdu</i>	<i>ierdu</i>	<i>njerdu</i>
eye	...	<i>ombula</i>	<i>ngombula</i>	<i>ngun-gubula</i>	<i>ombula</i>	<i>nyunggubula</i>
face (nose)	...	<i>arbingum</i>	<i>ngamingum</i>	<i>ngunmingum</i>	<i>imingum</i>	<i>nyimingum</i>
ear	...	<i>ardium</i>	<i>nganium</i>	<i>ngunium</i>	<i>inium</i>	<i>nyinium</i>
mouth	...	<i>arjamundu</i>	<i>ngaiamundu</i>	<i>ngunjamundu</i>	<i>iamundu</i>	<i>njamundu</i>
tooth	...	<i>arwiuk</i>	<i>nganbiuk</i>	<i>ngunbiuk</i>	<i>iwiuk</i>	<i>nyimbiuk</i>
forehead	...	<i>arbulara</i>	<i>ngamlara</i>	<i>ngumlara</i>	<i>imlara</i>	<i>nyimlara</i>
beard	...	<i>arjawundum</i>	<i>ngaiwundum</i>	<i>ngunjuwundum</i>	<i>iawundum</i>	
chin	...	<i>arjangundu</i>	<i>ngaiangundu</i>	<i>ngunjungundu</i>	<i>iangundu</i>	<i>njangundu</i>
neck	...	<i>arjurup</i>	<i>ngaiurup</i>	<i>ngunjurup</i>	<i>irup</i>	<i>njurup</i>
trachea	...	<i>arlenggu</i>	<i>ngalenggu</i>	<i>ngulenggu</i>	<i>ilenggu</i>	<i>nylenggu</i>
shoulder	...	<i>arpundum</i>	<i>ngamundum</i>	<i>ngumundum</i>	<i>imundum</i>	<i>nyimundum</i>
upper arm	...	<i>arkullum</i>	<i>ngalum</i>	<i>ngun-gullum</i>	<i>alum</i>	<i>nyunggullum</i>
forearm	...	<i>arwundu</i>	<i>ngawundu</i>	<i>ngunbundu</i>	<i>iwundu</i>	<i>nyimbundu</i>
elbow	...	<i>arju</i>	<i>ngaiu</i>	<i>ngunju</i>	<i>iu</i>	<i>nju</i>
back	...	<i>arlerdu</i>	<i>ngalerdu</i>	<i>ngulerdu</i>	<i>ilerdu</i>	<i>nyilerdu</i>
abdomen	...	<i>argulum</i>	<i>ngan-ngulum</i>	<i>ngun-ngulum</i>	<i>ingulum</i>	<i>nyungulum</i>

N.B.—In the impersonal form the prefix *ar-* is a contraction from *arka* : they.

In the personal forms *nga-* from *ngaiu*, *ngun* from *ngunju* (*ngoonju*), *i-* from *inja*, *ny-* from *nyina*.

THE VERB "TO BE."

Indicative mood. Positive.

			Present tense.		Past tense.		Future tense.	
SINGULAR.	1.	...	Nganoong	... I am.	Nganina	... I was.	Ngehnu	... I shall be.
	2.	...	nganoong	... you are.	ngunina	... you were.	ngoonyanu	... you shall be.
	3.	masc.	kunnoong	... he is.	kunnina	... he was.	ehnu	... he will be.
	3.	fem.	nyinoong	... she is.	nyinina	... she was.	nyehnu	... she will be.
	3.	neut.	wuna kunoong	... it is.	kunina	... it was.	nyanu	... it will be.
			3. neut. mana	manoong	...	manina	...	niehnu
DUAL.	1.	a.	ngadungandu	... we two are	ngadinandu	... we two were	Ngarinandu	... we two shall be.
	1.	b.	adungandu	... " "	adinandu	... " "	arinandu	... " "
	2.	...	nyidungandu	... you two are.	nyidinandu	... you two were.	nyirinandu	... you two shall be.
	3.	m.	kunungandu	... they two are.	kunninandu	... they two were.	ehnu	... they two shall be.
	3.	f.	nyinungandu	... " "	nyininandu	... " "	nyehandu	... " "
	3.	n.w.	kunungandu	... " "	kuninandu	... " "	nyanandu	... " "
PLURAL.	3.	n.m.	manungandu	... " "	maninandu	... " "	niehmanu	... " "
	1.	a.	ngadunguri	... we three are.	ngadinuri	... we three were	ngarinur	... we three shall be.
	1.	b.	adunguri	... " "	adinuri	... " "	arinuri	... " "
	2.	...	nyidunguri	... you three are.	nyidinuri	... you three were.	nyirinuri	... you three shall be.
	3.	m.	kunninguri	... they three are.	kunninuri	... they three were	ehnu	... they three shall be.
	3.	f.	nyinunguri	... " "	nyininuri	... " "	nyehnu	... " "
PLURAL.	3.	n.w.	kununguri	... " "	kuninuri	... " "	nyanuri	... " "
	3.	n.m.	manunguri	... " "	maninuri	... " "	niehmanuri	... " "
	1.	a.	n adoong	... we (many) are.	ngadina	... we were.	ngadunnu	... we shall be.
	1.	b.	adoong	... " "	adina	... " "	adunnu	... " "
	2.	...	nyidoong	... you (many) are.	nyidina	... you were.	nyidunnu	... you shall be.
	3.	m.	kadoong	... they (many) are.	kadina	... they were.	kadunnu	... they shall be.
PLURAL.	3.	f.	Same as masculine.					
	3.	n.	Wuna and mana forms same as singular.					

N.B.—(1) In above abbreviations 1 is first person, 2 is second person. 3m is third masculine, 3f is third feminine, 3n.w. is third neuter wuna, 3n.m. is third neuter mana.

N.B.—(2) In first person plurals 1a is the inclusive form, *i.e.*, "we including you," 1b is the exclusive form, *i.e.*, "we, but not you."

N.B.—(3) Third person masculine and feminine are the same in third person plural of many.

N.B.—(4) Neuter plurals, both wuna and mana, are the same as singular.

Indicative Mood. Negative.

			Present tense.		Past tense.	
SINGULAR.	1.	...	Wa pungunin	... I am not.	Wa punguninya	... I was not.
	2.	...	poongunin	... you are not.	poonguninya	... you were not.
	3.	m.	pungunin	... he is not.	pungguninya	... he was not.
	3.	f.	pinyinin	... she is not.	pinyininya	... she was not.
	3.	n.w.	poongunin	... it is not.	poongguninya	... it was not.
DUAL.	3.	n.m.	pummunin	...	pummuninya	...
	1.	a.	puddingandu	... we two are not.	pu ddinyandu	... we two were not.
	1.	b.	pe lingandu	... " "	pedinyandu	... " "
	2.	...	pinyidin-gundu	... you two are not.	pinyidin-yandu	... you two were not.
	3.	m.	punggunin-gundu	... they two are not.	pungguninyandu	... they two were not.
PLURAL.	3.	f.	pinyinin-gundu	... " "	pinyinin-yandu	... " "
	3.	n.w.	poonggunin-gundu	... " "	poongguninyandu	... " "
	3.	n.m.	pummunin-gundu	... " "	pummuninyandu	... " "
	1.	a.	puddinguri	... we three are not.	pu ddinyuri	... we three were not.
	1.	b.	pedinguri	... " "	pedinyuri	... " "
PLURAL.	2.	...	pinyidin-guri	... you three are not.	pinyidin-yuri	... you three were not.
	3.	m.	punggunin-guri	... they three are not.	pungguninyuri	... they three were not.
	3.	f.	pinyinin-guri	... " "	pinyinyuri	... " "
	3.	n.w.	poonggunin-guri	... " "	poongguninyuri	... " "
	3.	n.m.	pummunin-guri	... " "	pummuninyuri	... " "
PLURAL.	1.	a.	puddin	... we many are not.	pu ddinya	... we many were not.
	1.	b.	pedin	... " "	pedinya	... " "
	2.	...	pinyidin	... you many are not.	pinyidin-y	... you many were not.
	3.	m. & f.	padin	... they many are not.	pa dinya	... they many were not.
	3.	n.w. & m.	Same forms as singular			

N.B.—(1) In future tense the negative forms are the same as in the present, distinguished by the future adverb picha.

N.B.—(2) The negative forms throughout are preceded by wa.

N.B.—(3) The same forms as the negative, but without wa, are the *Obligatory mood*. *E.g.*, Wa pungunin : I am not ; pungunin : I must be.

THE VERB "TO BE."

Imperative mood : in present tense only.

Singular.	1.	...	Nganinya	...	let me be
	2.	...	bunnu	...	be you
	3. m.	...	kuminya	...	let him be
	3. f.	...	nyininya	...	let her be
	3. n.w.	...	kuninya	...	let it be
	3. n.m.	...	maninya	...	" "
Dual.	1. a.	...	ngadinyandu	...	let us two be
	1. b.	...	adinyandu	...	let us two be
	2.	...	nyidandu	...	be you two
	3. m.	...	kuminyandu	...	let them two be
	3. f.	...	nyininyandu	...	" " "
	3. n.w.	...	kuninyandu	...	" " "
	3. n.m.	...	maninyandu	...	" " "
Tripl.	1. a.	...	ngadinyuri	...	let us three be
	1. b.	...	adinyuri	...	" " "
	2.	...	nyiduri	...	be you three
	3. m.	...	kuminyuri	...	let them three be
	3. f.	...	nyininyuri	...	" " "
	3. n.w.	...	kuninyuri	...	" " "
	3. n.m.	...	maninyuri	...	" " "
Plural.	1. a.	...	ngadu	...	let us be
	1. b.	...	adu	...	" "
	2.	...	nyidu	...	be you
	3. m. and f.	...	kadinya	...	let them be
	3. n.w. & m.	...	Same as singular		

Examples :—(Achu nganoong — I am sitting down, or I remain.)

Achu nganinya : let me remain.
achu bunnu : remain you (thou).
achu kuminya : let him remain
achu nyininya : let her remain.

Kaiug achu kuninya : let the stone remain.
Kabalba achu maninya : let the earth remain.

Subjunctive mood : in present and past tenses only.

Present tense.....			Past tense.		
Singular.	1.	... Ngan-ngunoong	... If (etc.) I am,	Ngan-ngunina	... If (etc.) I were, or had been.
	2.	... ngun-ngunoong	... If you are	ngun-ngunina	... If you had been.
	3. m.	... inggunnoong	... If he is.	inggunnina	... If he had been.
	3. f.	... nyunggunnoong	... If she is.	nyunggunnina	... If she had been.
	3. n.w.	... kunnoong	... If it is.	kunnina	... If it had been.
	3. n.m.	... munggunnoong	... " "	munggunnina	... " " " "
Dual.	1. a.	... ngarkoonyungandu	... If we two are.	ngarkuninandu	... If we two had been.
	1. b.	... arkoonyungandu	... " " "	arkuninandu	... " " "
	2.	... nyirkoonyungandu	... If you two are	nyirkuninandu	... If you two had been.
	3. m.	... inggunningandu	... If they two are.	inggunninandu	... If they two had been.
	3. f.	... nyunggunningandu	... " " "	nyunggunninandu	... " " " "
	3. n.w.	... kunnoongandu	... " " "	kuninandu	... " " " "
	3. n.m.	... munggunnoongandu	... " " "	munggunninandu	... " " " "
Tripl.	1. a.	... ngarkoonyunguri	... If we three are.	ngarkuninori	... If we three had been.
	1. b.	... arkoonyunguri	... " " "	arkuninori	... " " " "
	2.	... nyirkoonyunguri	... If you three are.	nyirkuninori	... If you three had been.
	3. m.	... inggunninguri	... If they three are.	inggunninori	... If they three had been.
	3. f.	... nyunggunninguri	... " " "	nyunggunninori	... " " " "
	3. n.w.	... kunninguri	... " " "	kuninori	... " " " "
	3. n.m.	... munggunninguri	... " " "	munggunninori	... " " " "
Plural.	1. a.	... ngarkunoong	... If we are	ngarkunina	... If we had been.
	1. b.	... arkunoong	... " " "	arkunina	... " " " "
	2.	... Nyirkunoong	... If you are	nyirkunina	... If you had been.
	3. m. and f....	Unggunnoong	... If they are.	unggunnina	... If they had been.
	3. n.w. and m.	Same as singular.			

N.B. The subjunctive mood is used in clauses introduced by hypothetical words such as *ngumba* : if, *wunawmuruu* ; when, etc. ; and in subsidiary clauses.

E.g.—I am : *nganoong* ; if I am : *ngumba ngan-ngunoong*.

He was : *kunnina* ; she knew that he was : *laibiru nyinina aua inggunnina*.

When he knew : *wunawmurm laibiru inggunnina*.

He knew : *laibiru kunnina*.

While he was there : *wulli achu inggunninchri* (participial form).

He was there : *achu kunnina*.

If you hear a noise, tell me.

Ngulla-ngulla ngumba nguru ngun-ngunoong, *minyara*.

Potential mood : present tense only.

Singular.	1.	...	<i>Pungunnu</i>	...	I can, or might, be.
	2.	...	<i>poongunnu</i>	...	You can, or might, be.
	3. m.	...	<i>punggunnu</i>	...	he can, or might, be.
	3. f.	...	<i>pinyinu</i>	...	she can, or might, be.
	3. n.w.	...	<i>poonggunnu</i>	...	it can, or might, be.
	3. n.m.	...	<i>pummunnu</i>	...	„ „ „
Dual.	1. a.	...	<i>pungadandu</i>	...	we two might be.
	1. b.	...	<i>pedandu</i>	...	„ „ „
	2.	...	<i>pinyidandu</i>	...	you two might be.
	3. m.	...	<i>punggunandu</i>	...	they two might be.
	3. f.	...	<i>pinyinandu</i>	...	„ „ „
	3. n.w.	...	<i>poonggunandu</i>	...	„ „ „
Triad.	3. n.m.	...	<i>pummunandu</i>	...	„ „ „
	1. a.	...	<i>Pungaduri</i>	...	we three might be.
	1. b.	...	<i>peduri</i>	...	„ „ „
	2.	...	<i>pinyiduri</i>	...	„ „ „
	3. m.	...	<i>punggunuri</i>	...	„ „ „
	3. f.	...	<i>pinyinuri</i>	...	„ „ „
Plural.	3. n.w.	...	<i>poonggunuri</i>	...	„ „ „
	3. n.m.	...	<i>pummunuri</i>	...	„ „ „
	1. a.	...	<i>pungadu</i>	...	we many might be.
	1. b.	...	<i>pedu</i>	...	„ „ „
	2.	...	<i>pinyidu</i>	...	you many might be.
	3. m. and f.	...	<i>padu</i>	...	they many might be.
	3. n. w. and m.	Same as singular.			

N.B.—(1) “Can” is expressed by potential mood, prefixed by *golleh* : *i.e.*, “finished” or “complete.”

E.g.—I can stay : *golleh achu pungunnu*.

N.B.—(2) “Might” is expressed by the potential form, with or without *ngunna*. *Ngunna* may precede or follow the verb. After words ending in some consonants *ngunna* is modified into *kunna*.

E.g.—I might be sick : *ara ngunna pungunnu*, or *ara pungunnu ngunna*.

It might be stinking : *worru ngunna poonggunnu*.

It might be a big fish : *jaia inaiir' kunna punggunnu*.

THE VERB "TO BE" : PASSIVE FORMS.

Indicative mood : positive.

		Present tense.	Past tense.	Future tense.
Singular.	1.	... Nganingaiengu	... nganingaiehna	... ngehningaieh
	2.	... nguningaiengu	... nguningaiehna	... ngunyaningaieh
	3. m.	... kunningaiengu	... kunningaiehna	... ehningaieh
	3. f.	... nyiningaiengu	... nyiningaiehna	... nyehningaieh
	3. n.w.	... kuningaiengu	... kuningaiehna	... nyaningaieh
	3. n.m.	... maningaiengu	... maningaiehna	... mehningaieh
Dual.	1. a.	... ngadingaiengandu...	ngadingaienandu	... ngaraningaiehyundu
	1. b.	... adingaiengandu	... adingaienandu	... aranningaiehyundu
	2.	... nyidingaiengandu	... nyidingaienandu	... nyiranningaiehyundu
	3. m.	... kunningaiengandu...	kunningaienandu	... ehningaiehyundu
	3. f.	... nyiningaiengandu	... nyiningaienandu	... nyehningaiehyundu
	3. n.w.	... kuningaiengandu	... kuningaienandu	... nyaningaiehyundu
Tripl.	3. n.m.	... maningaiengandu	... maningaienandu	... mehningaiehyundu
	1. a.	... ngadingaienguri	... ngadingaienuri	... ngaraningaiehwuri
	1. b.	... adingaienguri	... adingaienuri	... aranningaiehwuri
	2.	... nyidingaienguri	... nyidingaienuri	... nyiranningaiehwuri
	3. m.	... kunningaienguri	... kunningaienuri	... kunningaiehwuri
	3. f.	... nyiningaienguri	... nyiningaienuri	... nyiningaiehwuri
Plural.	3. n.w.	... kuningaienguri	... kuningaienuri	... kuningaiehwuri
	3. n.m.	... maningaienguri	... maningaienuri	... maningaiehwuri
	1. a.	... ngadingaiengu	... ngadingehna	... ngaraningaieh
	1. b.	... adingaiengu	... adingaiehna	... aranningaieh
	2.	... nyidingaiengu	... nyidingaiehna	... nyiranningaieh
	3. m. and f.	... kadingaiengu	... kadingaiehna	... arranningaieh
	3. n.w. and m.	Same as singular.		

N.B.—The passive forms of the verb "to be" mean "to become" or to "happen."

Indicative mood : negative.

		Present tense.	Past tense.
Singular.	1.	... Wa punguningaien	... Wa punguningaienya
	2.	... „ poonguningaien	... „ poonguningaienya
	3. m.	... „ pungguningaien	... „ pungguningaienya
	3. f.	... „ pinyiningaien	... „ pinyiningaienya
	3. n.w.	... „ poongguningaien	... „ poongguningaienya
	3. n.m.	... „ pummuningaien	... „ pummuningaienya
Dual.	1. a.	... Wa pungudingaien-gundu	... Wa pungudingaienyandu
	1. b.	... „ pedingaien-gundu	... „ pedingaienyandu
	2.	... „ pinyidingaien-gundu	... „ pinyidingaienyandu
	3. m.	... „ pungguningaien-gundu	... „ pungguningaienyandu
	3. f.	... „ pinyiningaiengundu	... „ pinyiningaienyandu
	3. n.w.	... „ poongguningaien-gundu	... „ poongguningaienyandu
Tripl.	3. n.m.	... „ pummuningaien-gundu	... „ pummuningaienyandu
	1. a.	... Wa pungudingaien-guri	... Wa pungudingaienyuri
	1. b.	... „ pedingaienguri	... „ pedingaienyuri
	2.	... „ pinyidingaien-guri	... „ pinyidingaienyuri
	3. m.	... „ pungguningaien-guri	... „ pungguningaienyuri
	3. f.	... „ pinyiningaien-guri	... „ pinyiningaienyuri
Plural.	3. n.w.	... „ poongguningaien-guri	... „ poongguningaienyuri
	3. n.m.	... „ pummuningaien-guri	... „ pummuningaienyuri
	1. a.	... Wa puddingaien	... Wa puddingaienya
	1. b.	... „ pedingaien	... „ pedingaienya
	2.	... „ pinyidingaien	... „ pinyidingaienya
	3. m. and f.	... „ padingaien	... „ padingaienya

N.B.—Future tense is same as present.

Subjunctive mood : present and past tenses only.

		Present tense.		Past tense.	
Singular.	1.	...	Ngannguningaiengu	...	Ngan-nguningaiehna
	2.	...	Ngun-nguningaiengu	...	ngun-nguningaiehna
	3. m.	...	inggunningaiengu	...	inggunningaiehna
	3. f.	...	nyunggunningiengu	...	nyunggunningaiehna
	3. n.w.	...	kunningaiengu	...	kunningaiehna
	3. n.m.	...	munggunningaiengu	...	munggunningaiehna
Dual.	1. a.	...	ngarkuningaiengandu	...	ngarkuningaiehnandu
	1. b.	...	arkuningaiengandu	...	arkuningaiehnandu
	2.	...	nyirkuningaiengandu	...	nyirkuningaiehnandu
	3. m.	...	inggunningaiengandu	...	inggunningaiehnandu
	3. f.	...	nyunggunningaiengandu	...	nyunggunningaiehnandu
	3. n.w.	...	kunningaiengandu	...	kunningaiehnandu
	3. n.m.	...	munggunningaiengandu	...	munggunningaiehnandu
Tripl.	1. a.	...	ngarkuningaienguri	...	ngarkuningaiehnuri
	1. b.	...	arkuningaienguri	...	arkuningaiehnuri
	2.	...	nyirkuningaienguri	...	nyirkuningaiehnuri
	3. m.	...	inggunningaienguri	...	inggunningaiehnuri
	3. f.	...	nyunggunningaienguri	...	nyunggunningaiehnuri
	3. n.w.	...	kunningaienguri	...	kunningaiehnuri
	3. n.m.	...	munggunningaienguri	...	munggunningaiehnuri
Plural.	1. a.	...	ngarkuningaiengu	...	ngarkuningaiehna
	1. b.	...	arkuningaiengu	...	arkuningaiehna
	2.	...	nyirkuningaiengu	...	nyirkuningaiehna
	3. m. and f.	...	unggunningaiengu	...	unggunningaiehna
	3. n.w. and m.	...	Same as singular.		

Potential mood : present tense only.

Singular.	1.	...	Punguningaieh
	2.	...	Poonguningaieh
	3. m.	...	pungguningaieh
	3. f.	...	pinyiningaieh
	3. n.w.	...	poongguningaieh
	3. n.m.	...	pummuningaieh
Dual.	1. a.	...	Pungudingaiehyundu
	1. b.	...	pedingaiehyundu
	2.	...	pinyidingaiehyundu
	3. m.	...	pungguningaiehyundu
	3. f.	...	pinyiningaiehyundu
	3. n.w.	...	poongguningaiehyundu
	3. n.m.	...	pummuningaiehyundu
Tripl.	1. a. ...	...	pungudingaiehwuri
	1. b.	...	pedingaiehwuri
	2.	...	pinyidingaiehwuri
	3. m.	...	pungguningaiehwuri
	3. f.	...	pinyiningaiehwuri
	3. n.w.	...	poongguningaiehwuri
	3. n.m.	...	pummuningaiehwuri
Plural.	1. a.	...	puddingaieh
	1. b.	...	pedingaieh
	2.	...	pinyidingaieh
	3. m. and f.	...	padingaieh
	3. n.w. and m.	...	Same as singular.

Part II. of this paper will be published in a later volume.

4.—THE OLIGOCHAETA OF SOUTH-WESTERN AUSTRALIA.*

BY ADA JACKSON, M.Sc.

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<i>P. albanensis</i> , Michlsn	<i>E. foetida</i> , Sav.
<i>Pl. albanensis</i> , var <i>eygni</i> .	Genus <i>Helodrilus</i>
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<i>P. bermudensis</i> forma <i>ephip-</i>	<i>H. parvus</i> , Eisen.
<i>piger</i> , Rosa	<i>H. constrictus</i> , Rosa

* A contribution from the Department of Biology in the University of Western Australia.

An account of the oligochaetes of South-Western Australia was published by Professor W. Michaelsen, of Hamburg, in 1907, the work being the result of a six-months tour made in company with Dr. R. Hartmeyer. He found the country rich in earthworms the vast majority of which belonged to new and endemic species. This was only to be expected in a region such as this, where the rainfall is good and where desert country makes migration to or from the eastern states almost impossible, but it is curious to note that almost every locality is characterised by its own species which for some reason are restricted to that district. The result is that an extraordinarily large number of species are represented; Michaelsen recorded fifty-two, and another twelve species and one variety must now be added to the list. The discovery of these twelve new species is not the result of an organised search, but specimens have been collected together with other creatures during occasional excursions during the past two years. Of the fifty-two species mentioned by Michaelsen only nine have since been found, though it must be admitted that very few of the same localities have been explored.

Michaelsen states that he found *Helodrilus caliginosus* Sav. and *Microscolex dubius* (Fletcher), both forms which have been introduced by man, at almost every station where he collected. The preponderance of these two species has also been shown, so far as *H. caliginosus* is concerned in recent collections, but *M. dubius* does not appear to be quite so common in the districts where this collecting was done, that is, in the neighbourhood of Perth and in the unfarmed districts round Nornalup. It has however been found in three places, on the island of Rottnest, near the sea coast at Cottesloe, and inland at Wongong.

Of the other introduced forms, *Pheretima heterochaeta* Michlsn. and *Eisenia foetida* Sav., have again been found. *Eisenia foetida* was recorded by Michaelsen from Albany, and concerning it he stated that as yet it had not spread from the locality where it was first introduced. Recently specimens have been taken at Monger's Lake and Kalgoorlie. It is scarcely possible that in a few short years they could have reach these two places by natural means, and improbable that loads of soil would be taken from Albany to the far more fertile districts round Kalgoorlie, but it may be that the worms have been transported in small quantities of soil, possibly with pot-plants.

A new species of the genus *Eiseniella* is also described in the following pages. Though hitherto unknown it is doubtful whether this species is endemic, for the Lumbricidae are for the most part northern-hemisphere forms, and no genera or species are known to be native to Western Australia. It is however possible that under the conditions of a new habitat it may have developed from the introduced *Eiseniella tetraedra* Sav.

With one exception all of the new species here described are megadriles. No attempt has been made to extend the knowledge of West Australian microdriles, though, contrary to the accepted idea, these small worms are very abundant. *Dero* and *Nais* in particular are quite common and when worked out will probably be found to represent a number of species.

Concerning the indigenous megadriles Michaelsen comments on the small size of the individuals. Recent collections have also gone to show that the vast majority are decidedly small, but *Megascolex swarbricki* Nicholls and Jackson and *Megascolex syndetoporus*, sp. nov., both attain a moderate size, while one specimen of *Megascolex imparicystis* Michlsn. when extended measured 450 mms.

The sub-family Ocerodrilinae is recorded from Western Australia for the first time, in the genus *Kerria* Beddard. Specimens of a species of this genus were found in a market garden on the banks of the Swan River, and since the river was unusually high at the time it seemed probable that they had been washed down by the flood waters from some locality further up the river. A short time after, however, large numbers were again taken. In view of the distribution of the genus, which is chiefly confined to the north of South America, it seems more probable that the present species has been introduced and has perhaps varied a little under the new conditions. If this is not so it is rather difficult to account for its occurrence.

Wegener's hypothesis of continental drift has recently been the cause of much discussion, and naturally it has been of interest to observe whether or not the earthworms of South-Western Australia lend any support to the theory. The Phreodrilidae, for example, occur in Australia, South Africa and South America, though not in India or Ceylon. This family offers the strongest support to the theory. Its members are found in localities that are far from human settlements and do not lie along the migratory tracks of any birds, so that its distribution cannot be accounted for by artificial means. The genus *Eodrilus* Michlsn., which has been separated from the older genus *Microsclex* (*Notiodrilus*), and from which most of Australia's oligochaete fauna has apparently developed, is restricted to the three southern continents and the intervening islands, but if it entered Australia by a southern route it is curious that no members of the genus have been found either in Tasmania, Victoria, or New South Wales. It is of course possible that further search may reveal them, or it may be that in those regions the genus died out during the glacial age, but at present it cannot be proved either that it entered from the south or from the north.

As regards distribution within the State, Michaelsen's reports are far the most part confirmed. He found that each genus was apparently restricted to a limited area, due presumably to the pressure of neighbouring forms which prevents rapid spreading. Species found since then have, with two exceptions, been true to these generic districts. The exceptions are *Megascolex* and *Plutellus*. A number of species of *Megascolex* were found in the extreme South-West, that is, in the districts where they were to have been expected, but two, *M. longicystis* and *M. imparicystis*, were collected near Perth. Only two specimens of the latter species had been found before and in both cases the locality label had been lost. Possibly they came from the environs of Perth, but in any case it seems that the *Megascolex* region extends as far north as Perth. Concerning *Plutellus*, a species was found at Yalgoo, that is, no further north but much further inland than any recorded previously.

In the following account the family and generic diagnoses and the descriptions of species previously recorded have been based upon those in Michaelsen's two works on Oligochaeta: "*Die Fauna Sudwest Australiens*" Band 1, Lief 2, and "*Das Tierreich*" Lief 10. New species are described in greater detail and specific keys have been compiled, but these include only species found in Western Australia. For the synonymy the reader is referred to the above-mentioned works. As regards terminology, that of Michaelsen is used for the most part, though the term "*spermiducal gland*" is preferred to "prostate," "*Puberstatsorgane*" translated as "accessory gland," and only definite outgrowths of the oesophagus referred to as "calciferous glands."

KEY TO THE FAMILIES OF OLIGOCHAETA.

- | | | |
|-----|---|----------------------------|
| 1. | { Asexual reproduction prevails, a budding-zone giving rise to chains of animals—2. | |
| | { Asexual reproduction does not normally occur—3. | |
| 2. | { The brain connected with the hypodermis ; septa generally lacking (septum 1/2 rarely developed) | 1. FAM. AELOSOMATIDAE. |
| | { Brain free in the body cavity ; septa occur | 2. FAM. NAIDIDAE. |
| 3. | { Spermathecal pores in furrow 4/5 rarely in 3/4 and 4/5 ; oesophagus without a gizzard | 6. FAM. ENCHYTRAEIDAE. |
| | { Spermathecal pores sometimes lacking, rarely in furrow 4/5 (in this case the oesophagus has a gizzard) usually more posterior—4. | |
| 4. | { 1 pair of ovaries, usually in seg. 13, rarely further forward (in which case the mid-gut has 2 or more gizzards), or 2 pairs in segs. 12 and 13 -7. | |
| | { Ovaries in seg. 11 or 12 or further forward ; mid-gut without a gizzard -5. | |
| 5. | { 1 pair of seminal funnels in the segment which bears the male pores, and usually a second pair in the proceeding segment | 5. FAM. LUMBRICULIDAE. |
| | { 1 pair of seminal funnels in the segment proceeding that which bears the male pores—6. | |
| 6. | { Spermathecae anterior to the genital organs | 3. FAM. TUBIFICIDAE. |
| | { Spermathecae posterior to the genital organs | 4. FAM. PHREODRILIDAE. |
| 7. | { 2 or more gizzards at the beginning of the mid-gut ; male pores in furrow 12/13 or still further forward | 9. FAM. MONILIGASTRIDAE. |
| | { Usually only 1 or no gizzard at the beginning of the mid-gut ; should there be more the male pores lie in seg. 18 or in furrow 17/18 -8. | |
| 8. | { 2 pairs of male pores | 8. FAM. HAPLOTAXIDAE. |
| | { 1 pair of male pores—9. | |
| 9. | { Male pores in seg. 13, no gizzard at the beginning of the mid-gut | 7. FAM. ALLUROIDIDAE. |
| | { Male pores usually more or less posterior to seg. 13 ; if they occur in seg. 13 a gizzard is present at the beginning of the mid-gut—10. | |
| 10. | { A well-developed gizzard at the beginning of the mid-gut | 12. FAM. LUMBRICIDAE. |
| | { No well-developed gizzard at the beginning of the mid-gut (rarely a rudimentary gizzard)—11. | |
| 11. | { Spermiducal glands usually occur (lacking only in forms which have a single pair of oesophageal pouches and a single pair of spermathecae in seg. 9, or are beset with numerous setae per seg., which condition does not happen in the Glossoscolecidae | 10. FAM. MEGASCOLECIDAE. |
| | { Spermiducal glands usually lacking (occurring only in forms in which the clitellum begins behind the male pore ; or the spermathecae are numerous on each side and open in groups along the furrow, without the setae becoming numerous in each segment, which condition does not happen in the Megascolecidae | 11. FAM. GLOSSOSCOLECIDAE. |

2.—Family NAIDIDAE.

Genus PRISTINA Ehrbg.

Prostomium usually drawn out in a tentacular fashion. Setae of the ventral bundle sigmoid, with a forked tip ; those of the dorsal bundle hair-like and beginning on segment 2. Genital organs of one species 2 segments behind the normal position in the Naididae, *i.e.*, testes in segment 7, ovaries in segment 8, spermathecae in segment 7.

In fresh water. Europe, North and South America, East Africa, India, Australia, Java.

Pristina longiseta, Ehrbg.

Prostomium elongated and either conical or thread-like, without eyes ; ventral setae of equal length ; dorsal setae in bundles of 2 or 3, those of the 3rd and following segments enormously lengthened, reaching in the case of segment 3 to the tip of the prostomium ; brain moderately deeply indented both anteriorly and posteriorly, the indentations forming a fairly sharp angle in each case ; stomach in segment 8 ; simple transverse commisural vessels in segments 3–8, those in 8 being swollen and heart-like.

Locality : Brunswick, in a brook.

Distribution : North America (Illinois, Pennsylvania), South America, (Paraguay, Chile, North Argentine) Europe (England, Belgium, Denmark, Germany, Bohemia, Switzerland), Africa (German East-Africa), India (Punjab, Gwalior, Travancore).

Genus *DERO* Oken.

Prostomium rounded, without eyes. Setae in 4 bundles per segment : ventral setae sigmoid with a forked tip, those in segments 2-5 longer than the rest ; dorsal bundles begin usually in segment 6, rarely in 5, and contain 1 hair seta and 1 or 2 needle setae with differently formed distal tips ; hinder end widens to a cup-shaped branchial area within which are paired branchiae ; gut with a gizzard-like dilatation ; dorsal vessel, communicating with the ventral vessel through several transverse vessels, usually simple ; the blood is red. Nephridia paired and with glistening funnels, occurring from segment 6 on. Testes in segment 5, ovaries in segment 6, spermathecae in segment 5.

In fresh water. Europe, North America, Antilles, tropical East Africa, Tonkin, Philippines, West Australia, India (Lahore).

Dero roseola, Nicholls.

1921 *Dero roseola* Nicholls. Journ. Roy. Soc. W.A., VII., p. 90, pl. 14.

Segments, 75. Branchial area funnel-shaped, bearing a pair of mobile cylindrical palpi and 3 pairs of ciliated branchiae, cylindrical in shape and almost of equal length but slightly shorter than the palpi. The first pair of dorsal setae bundles occurs in segment 5. The first pair of ventral setae bundles, in segment 2, consists of but 3 setae apiece. Succeeding ventral bundles have each four setae. The worm is of a delicate pink colour, reaches a length of 12mm., and is rarely found inhabiting a tube, but may be found collected into dense clusters forming a distinct pink mass.

Locality : South Perth, in a trough supplied by mineral water from a deep bore.

3.—Family TUBIFICIDAE.

Genus *CLITELLIO* Sav.

Setae of both dorsal and ventral bundles of the forked sigmoid type. Male pores in segment 11, spermathecal pores in segment 10. A suprain-testinal vessel occurs but there is no integumental plexus. Atrium simple, prostate lacking. Penis without a chitinous sheath. Spermatophores occur in the spermathecae. Found at high-tide level on the coast of Europe and Western Australia.

Clitellio abjornseni, Michlsn.

Setae sigmoid and forked, with a nodulus. 3-4 setae in each dorsal bundle, 4-5 in each ventral, though the number is smaller in both cases in the last seta-bearing segment and the ventral bundles in segment 11 are lacking. The clitellum covers segments 11 and 12. Spermathecal pores in furrow 9/10. Seminal funnels cup-shaped each leading to a short neck-like vas deferens. Atria thick, ampulla-shaped, and bent, narrowing to open directly by the male pore. Spermathecae slender, pyriform, and bent, each leading to a short, narrow, non-glandular duct opening at the apex of a flattened papilla.

Length 3mms., diameter .3mm., number of segments 24.

Locality: West Australia. Melville water, in the Swan River (salt-water), in sand at the water's edge.

East coast of Rottnest, on the ocean shore.

Princess Royal Harbour, Albany, between tide levels and at $5\frac{1}{2}$ –9 metres.

4.—Family PHREODRILIDAE.

In 1904 Michaelsen proposed that the genera *Phreodrilus* (Beddard) and *Hesperodrilus* (Beddard) should be united and that they should be removed from the Tubificidae. This is the result of the discovery of two new genera showing definite relations to *Phreodrilus* and to each other. Benham established a new family for the reception of the members of this group so that the family Phreodrilidae, as now constituted, includes three genera, *Phreodrilus* Beddard, *Phreodriloides* Benham, and *Astacopsidrilus* Goddard, represented by species occurring in New Zealand, South America, Kerguelen Island, Tasmania, and Australia.

Goddard (1908) considers that the Phreodrilidae are the remnants of an old antarctic stock, and that they have been forced by climatic and competitive conditions to take to a subterranean life and to invade more temperate regions. He bases this suggestion on the condition of habitat, the small number of forms constituting the family, and the geographical distribution. If this supposition is correct it is interesting to note that a species has been found as far north as Kalamunda, $31^{\circ} 40' S.$, but here, it should be noted, with subterranean habitat. In all, nine specimens have been found, in a pool at the foot of Lesmurdie Falls after heavy rains. The pool is very small and dries up during the summer—in fact it is only during exceptionally wet seasons that it appears at all. The Phreodrilid, because of its transparency and minute size is difficult to see, and can only be found by collecting mud which must be carefully examined, a very little at a time. The first specimens were collected in 1926 but only one was successfully sectioned. During the following winter season (1927) efforts were made to obtain more material, but several excursions to the pool resulted only in the finding of four specimens, all immature. It is however interesting to note that during both years the pool yielded specimens of two blind colourless crustacea (*Phreatoicoides plumosus* Nicholls and Milner, and *Protocrangonyx fontenalis* Nicholls), a colourless translucent planarian, and, on the last occasion, a colourless Gordioid worm. The natural conclusion is that these are all subterranean forms which have been forced to the surface by the uprush of flood water from some deep spring. The association of oligochaete, crustacean, and planarian is curious in that it also occurs in subterranean wells in New Zealand; indeed it was there and in such association that Beddard found his first specimens of the genus *Phreodrilus*.

The fact that the *Phreodrilidae* either lead a subterranean life or are to be found in the depths of fresh-water lakes suggest that though they may be gradually invading warmer regions their conditions of habitat have not undergone much alteration. Even those forms occurring in New South Wales and Victoria live under Alpine conditions, *Phreodriloides* inhabiting Blue Lake, Mt. Kosciuszko, and *Astacopsidrilus* living in association with fresh-water crayfish in regions high above sea level.

The specimens from Kalamunda described in the following pages are provisionally attributed to the genus *Astacopsidrilus* Goddard, though it was not found in association with crayfish, as were the other two species of the genus. This classification is based chiefly upon the curious duct-like struc-

tures in segment 12 which in their position and relation to the spermathecae show affinity with the funnel-structures described by Goddard (1908) in *Astacopsidrilus notabilis*. They are, however, much more specialised in the specimens here described. Probably of major importance are the facts that two pairs of testes occur and that, in some cases at least, both of the setae of the ventral bundle are of the bifid type. If further investigation confirms these facts there seems to be little doubt but that it will be necessary to establish a new genus for its reception.

***Astacopsidrilus* Novus, Sp. nov.**

Pl. XVI.

Figs. 1, 2, 3.

External features : The specimens taken were colourless and translucent, varying in length from 7-10 mms.

The ventral setae are arranged in bundles of two and are sigmoid without a nodule. When the worms were first examined it was thought that both the setae of the ventral bundle were bifid but in revising the work later some doubt was cast upon the matter. Certainly in some cases both are bifid, though always the prong on the convex curve of the seta is shorter and more delicate than the other, but in some of the bundles one seta appears to be simple and slightly longer than the other ; whether this is actually the case or merely due to the angle at which the setae are lying and the difficulty of exact observation is a matter which cannot be settled until fresh specimens are obtained. If the bifid type of setae is constant for the ventral bundles it would seem to indicate that the species is more closely related to the Tubificidae than are the rest of the Phreodrilidae, where one of the ventral setae is always simple. The dorsal setae are long, slender, needle-like, and sometimes slightly curved. The first bundle contains two such setae but in segments 3-5 the number increases to 4 or 5 ; in the succeeding segments it diminishes again until from segment 13 onward only one needle-like setae occurs in each dorsal bundle.

The clitellum forms a cingulum round the posterior half of segment 12 and the whole of segment 13.

No pores could be distinguished without cutting serial sections, when it was found that the male pores lie in segment 12 at the interior margin of the clitellum and the female at the anterior margin of segment 13.

Anatomy : The septa are nowhere noticeably strengthened, while that between segments 11 and 12 seems to have broken down entirely.

The male genitalia is exceptional in that it includes two pairs of testes, one pair attached to the anterior wall of segment 10, the other in a similar position in segment 11 ; there is a pair of large spermiducal glands, and an extrusible penis, also paired. No spermiducal funnels or vasa deferentia could be distinguished in the sections. The presence of two pairs of testes distinguishes the species from the three known genera of Phreodrilids, but since the present description is based chiefly upon serial sections of one specimen it seems premature to separate the worm entirely from these forms. The testes are, however, extremely large and conspicuous and if further investigation shows that two pairs are constant in occurrence the feature will, together with other peculiarities, be sufficient to justify the establishment of a new genus.

The spermiducal glands are extremely large and project forward into segment 11 ending directly opposite the second pair of testes. They consist

remains of paired spermathecae which have fused, in which case he claims that his specimen represents a new genus ; otherwise it is probably a species of *Phreodrilus*. These chambers with their ellipsoid particles also seem to resemble the "opaque bodies" described by Stephenson (1909) as occurring in the Naididae. No satisfactory explanation of such structures has as yet been offered ; their appearance suggests that they may be masses of coelomic corpuscles concentrated in the genital region, but if this is so there seems to be no reason why a membrane should be developed about them.

6.—Family ENCHYTRAEIDAE.

1.—Genus ENCHYTRAEUS Henle, em. Michlsn.

Setae in 4 bundles, 2 ventral and 2 lateral, straight and of equal length in each bundle. Head-pore small, between the prostomium and segment 1 ; dorsal pores lacking. Dorsal vessel post-clitellial in origin ; blood colourless ; hearts lacking. Lymphocytes of uniform shape. Peptonephridia may or may not occur. Oesophagus gradually merges into the mid-gut. Duct of the nephridium usually very short, opening at the posterior end of the post-septal region. Vas deferens long. Spermathecae without a diverticulum and communicating with the gut.

Usually between tide levels, also in river banks, garden earth, etc. Nova Zembla, Europe, Greenland, Massachusetts, South Brazil, South Patagonia, South Georgia, India, South-West Australia.

Enchytraeus albidus, Henle.

Pl. XVI. Fig. 10.

In life milky-white or yellowish. Setae 3-5 rarely 6 per bundle, straight and of equal length. Brain longer than wide, anterior border concave, posterior border slightly concave, straight, or faintly convex with side margins very slightly divergent backwards. 1 pair of peptonephridia, consisting of unbranched irregularly-twisted ampullae opening into the gut dorsally just behind the pharynx. Lymphocytes flat and varying from an irregular oval to pear-shaped. Blood colourless or yellow. Nephridia with a small simple pre-septal region and a large broad elliptical post-septal region, the duct, which is nearly as long as the post-septal region, opening from the posterior pole. Seminal funnels 4-6 times as long as wide. The spermathecae with an irregular sac-like ampulla often swollen on one side only, and a distinct duct nearly as long as the ampulla, the distal half of the duct being beset with numerous closely-pressed pear-shaped glands.

Length 10-35 mms. ; diameter .5-1mm. ; number of segments 53-74.

Locality : Albany, Princess Royal Harbour. At a depth of $5\frac{1}{2}$ -9m., Geraldton, on the ocean beach.

Albany, Princess Royal Harbour, between tide levels.

Nornalup, in a decaying *Macrozamia* on the shore of the Inlet.

Distribution : Nova Zembla, Solovetski Is., Denmark, Germany, Bohemia, Switzerland, Greenland, Massachusetts, Uruguay, South Patagonia, south coast of Tierra del Fuego, South Georgia, South-West Australia.

Remarks : Eisen ('04, fide Welch '14) in his definition of the genus *Enchytraeus* states that there is "no single penial bulb, but one or more isolated glandular papillae situated in the vicinity of the spermiducal pores, gener

of elongated glandular cells surrounding a narrow lumen ; apically the lumen widens into a distinct chamber which is filled with spermatzoa. Since no spermiducal funnels could be seen it was at first thought that they were represented by these chambers, the wall of the vas deferens being extremely thick and glandular. Close examination, however, failed to reveal any opening between the chamber and the body-cavity, and it was therefore concluded that the structure is prostatic in nature.

The penis sheath is extremely long and is built up of a muscle layer and a layer of indistinctly defined spongy-looking cells. One specimen was found after fixation to have the sheath of one side partially everted, but though the long sheath is eversible the penis proper can apparently only be extruded. The apex of the penis is sharp and the duct is surrounded by a thick cortex of spongy looking material in which no cell limits can be distinguished.

Well defined sperm sacs occur some distance behind the rest of the genitalia, apparently in segment 16, though owing to the curved condition of the specimen and the indistinctness of the septa it was not possible to be quite certain as to the segment. A quantity of ripening sperm matter was also found lying freely in the hinder region of segment 13 and in segment 14.

The ovaries project into segment 12 from the posterior surface of septum 11/12. The ova are large, irregular, and lightly granulated. They appear to develop in groups which break away from the ovary as they mature and finally separate into individual ova which lie free in the body cavity. Opposite each ovary is a large duct-like structure with an extremely wide lumen. This structure corresponds in position with the funnel-structures of *Astacopsidrilus* as described by Goddard (1908), but no oviduct could be made out in connection with it. The structure terminates in a hemispherical group of elongated glandular cells from the centre of the base of which two tiny sigmoid setae project into the lumen. The function of these setae is probably related to the act of copulation and the organ functionally a vagina. It extends backwards towards an atrium which opens to the exterior by a large pore at the anterior margin of segment 13, but the actual point of entry of the duct into the atrium could not be made out.

The spermathecae lie in segment 13, one slightly anterior to the other. They are ovoid structures lined by thin-walled irregular cells ; the ducts are stout and taper away as they approach the female atrium. These ducts for the greater part of their length contain a solid core which in transverse section was at first taken to be a spermatophore, but distally no lumen at all can be distinguished which suggests the possibility that a former connection with the exterior has degenerated into a solid strand of cells—a condition similar to that described by Goddard in *Astacopsidrilus*, though there a connection with the funnel-structures is retained. It seems impossible in the present case that this duct should have become solid, for if so the sperm would have no means of access to the spermathecae, where however, they are present in numbers.

Segments 13 and 14 contain large thin-walled ovoid chambers packed with tiny granular ellipsoid particles. The extent of these chambers varies and in one specimen they invade as many as five segments (11-15). Similar particles are described by Goddard (1908) in *Astacopsidrilus notabilis* ; he suggests that they may be derived from the epithelial lining of the spermathecal sacs, though he makes no suggestion as to their significance. He also found them in the immature worm collected from small pools on the Mount Wellington plateau, Tasmania, though here they were contained in numerous definite and regular spherical chambers. He suggests that they may be the

ally and principally ventral to the pores." Welch ('14) denies this since a single compact penial bulb occurs in *E. gillettensis* and *E. nodosus*, and also in *E. mobii* with which *E. albidus* is synonymus. He does not figure the bulb in *E. albidus*, merely stating that it agrees exactly with that of *E. mobii* as described by Michaelsen in his "Untersuchungen über *Enchytraeus mobii* (Mich.) und andere Enchytraeiden," and that it consists of a number of fascicles with a large central division of the lumbricillid type, *i.e.*, muscular strands do not penetrate the bulb. Since, however, the above work is not available, a "camera lucida" drawing has been made of a section through the penial bulb of one of the specimens from Nornalup. It will be noticed that there are no fascicles and that muscle strands do penetrate the glandular mass.

2.—GENUS MICHAELSENSA Udo.

Setae and setal-sacs decreased in number near the spermathecal pores, the few setae which occur being straight. Head-pore small, between the prostomium and segment 1. Lymphocytes all of the same shape. Peptonephridia lacking. Oesophagus simple, gradually merging into the mid-gut. Dorsal vessel post-clitellial in origin and devoid of hearts. Spermathecae without a diverticulum and communicating with the gut.

Between tide levels. South Patagonia, South Tierra del Fuego, and South-West Australia.

1.—*Michaelsena principissae*, Michlsn.

Setae large and straight except for a slight proximal bend. They are arranged singly, beginning ventrally on segment 3, dorsally on segment 14. The clitellum covers segments 12 and 13. The male pores are on small papillae. 3 pairs of septal glands occur with a number of secondary glands attached to the axial cord. The dorsal vessel arises from the gut-plexus in segment 13, or further back. The brain narrows considerably in front. It is at least twice as long as the maximum breadth, and has a deep median posterior indentation which divides it into 2 lobes converging to an angle of about 45°. The vas deferens is long and coiled and provided distally with a spherical penial bulb. The spermatheca is an inverted pear-shape containing four sperm chambers and communicating proximally with the oesophagus. The duct is about 3 times as long as its diameter, smooth, devoid of investing glands, and narrowing distally.

Length: $4\frac{1}{2}$ mms. ; diameter .15 mm. ; number of segments, 27.

Locality: Albany, Princess Royal Harbour, at low tide.

2.—*Michaelsena normani*, Michlsn.

Setae straight with a slight proximal curve, beginning ventrally on segment 3. Lateral setae only occur on segments 4-6. The setae of the anterior end paired but from segment 10 on they stand singly. The posterior setae are somewhat larger than the anterior, being about 33u in length, as against 20u. Anatomy not clear owing to lack of material.

Locality: Brunswick, in a brook.

3.—GENUS FRIDERICIA Michlsn.

Setae in 4 bundles, straight and, if there are only 2 in a bundle, of equal length. If there are more in a bundle the innermost 2 are of equal length and shorter than the next pair, so that the two outermost setae are the longest. Dorsal pores occur usually from segment 7, rarely from 6. Head-

pore usually small and placed dorsally between the prostomium and segment 1. Lymphocytes of two kinds. Peptonephridia always present. The oesophagus merges gradually into the mid-gut. Dorsal vessel post-clitellial in origin; blood colourless. Nephridia usually with a large pre-septal region in which the duct begins its convolutions. Vas deferens long. Spermathecae usually communicate with the gut and may be simple or with a diverticulum.

In earth, under moist leaves, moss, etc. Siberia, Nova Zembla, Spitzbergen, Europe, North America, South Brazil, Uruguay, Chili, New Zealand, South-West Australia, India, Natal. Probably cosmopolitan.

Fridericia galba, Hoffm.

In life greyish-white to yellowish, slightly transparent. The setal bundles consists of 4-6, rarely 3 setae. Brain twice as long as wide, faintly convex before and behind. Peptonephridia broad and band-like with a slight dicotomous branching posteriorly. The dorsal vessel arises behind the clitellum. Nephridia with a large oval anteseptal region and a post-septal region which varies from the same size to 3 times the length; the duct passes out laterally, just before the hinder end of the post-septal region. Seminal funnels 3-4 times as long as wide, with a narrow turned-back lip. Spermathecae communicate with the gut and consist of a large sugar-loaf-shaped ampulla into the base of which open 3-5 (usually 4) stalked spherical diverticula, and a slender duct about twice as long as the ampulla.

Locality: Albany, in rich marshy earth.

Distribution: Europe and New Zealand.

8.—Family HAPLOTAXIDAE.

Genus *PELODRILUS* Bedd., emend.

Setae in 4 pairs in each segment. Nephridial pores in the line of the ventral pair of setae. Clitellum covering several segments. 2 pairs of male pores; 1 pair of spermathecal pores in furrow 6/7 or 7/8. Oesophagus simple, without a gizzard or glandular appendages. Testes and seminal funnels may or may not be enclosed in a sperm reservoir.

Terrestrial: New Zealand and South-West Australia.

1.—*Pelodrilus darlingensis*, Michlsn.

Unpigmented and translucent, the head region with a reddish-yellow tone. Head zygotelous with a short broad prostomium. Setae ventral and lateral in position and closely paired. Male pores in segments 11 and 12 in the *b* line of setae; 1 pair of female pores in furrow 12/13; spermathecal pores in furrow 7/8 slightly above the *c* line of setae. Large lobed salivary glands in segments 5-9, the ducts extending as thick cords to open through the dorsal pharynx. Nephridia occur from segments 5, including the genital segments. Sperm reservoir lacking; 2 pairs of testes and seminal funnels in segments 10 and 11; 2 pairs of sperm sacs in segments 9 and 12, and free sperm masses in 10 and 11; spermiducal glands lacking. 1 pair of ovaries in segment 12. Spermathecae with a fairly long sac-like ampulla and a short narrow duct. Length 25-35mms.; diameter, 1-1 1/3mm.; number of segments 80-95.

Locality: Collie, in marshy ground at the margin of a brook.

2.—*Pelodrilus hologynus*, Michlsn.

Generally grey, the white nephridia being visible through the skin, head region yellowish-white. Head zygalobous with a dome-like prostomium marked by a ring-like furrow which fades away laterally. 2 pairs of male pores in segments 11 and 12 in the line of the ventral setae; 2 pairs of female pores in furrows 12/13 and 13/14, spermathecal pores in furrows 6/7. Lobed salivary glands in segments 5–9; the oesophagus is swollen in these same five segments.

Nephridia first occur in segment 8 and are present in every succeeding segment (with the exception of the segment containing the ovaries?). Sperm reservoirs lacking, 2 pairs of testes and seminal funnels in segment 10 and 11, free, or embedded in free sperm masses; 2 pairs of sperm sacs in segments 9 and 12, Vasa deferentia coiled and opening on each side in the region of a nodular group of pear-shaped copulatory glands. 2 pairs of ovaries and oviducal funnels in segments 12 and 13. Spermathecae with a long twisted ampulla merging into a short narrow curved duct.

Length, 48–50mm.; diameter about 1mm.; number of segments, about 130.

Locality: Yarloop.

Harvey, in moist rich earth on the bank of a brook.

10. Family MEGASCOLECIDAE.

- | | |
|---|------------------------------|
| 1. { 1 pair of calciferous glands or oesophageal pouches in segment 9, sometimes united mid-ventrally ... | 3. SUB-FAM. OCNERODRILINAE. |
| 2. { Calciferous glands not, or not solely in segment 9—2. | |
| 2. { 2 or 3 gizzards anterior to the testes—segments—3. | |
| 3. { 1 or no gizzard before the 1st testes-segment—4. | |
| 3. { Plectonephridial | 4. SUB-FAM. TRIGASTRINAE. |
| 3. { Meganephridial | 5. SUB-FAM. DIPLOCARDIINAE. |
| 4. { Spermathecal pores posterior to furrow 8/9, sometimes united with the female's pores | 6. SUB-FAM. EUDRILINAE. |
| 4. { Spermathecal pores in or anterior to furrow 8/9, sometimes lacking—5. | |
| 5. { Vas deferens and spermiducal glands entirely separated or at most opening close to each other—6. | |
| 5. { Vas deferens opens into the spermiducal gland except when the latter is lacking | 2. SUB-FAM. MEGASCOLECINAE. |
| 6. { Plectonephridial | 7. SUB-FAM. OCTOCHAETINAE. |
| 6. { Meganephridial | 1. SUB-FAM. ACANTHODRILINAE. |

1.—Sub-family ACANTHODRILINAE.

1. Genus EODRILUS Michlsn.

8 setae per segment. Nephridial pores in a longitudinal line on each side, not alternating. Male pores in segment 18. Spermiducal glands opening by 2 pairs of pores in segment 17 and 19. Usually 2 pairs of spermathecal pores in furrows 7/8 and 8/9, rarely 4 median pores (or 3 pairs?). Gizzard well developed. 2 pairs of testes and seminal funnels projecting freely into segments 10 and 11.

Cape of Good Hope, Mexico, Colombia, Chile, Patagonia, New Caledonia, North and West Australia, Madagascar, West Africa (Cameroon).

Eodrilus cornigravei, Michlsn.

Grey and unpigmented, the white nephridia being visible through the skin. Setae closely paired ($ab = cd = \frac{1}{4}aa$, $aa = bc$, $dd = \frac{7}{12}u$). Head epilobous. Dorsal pores not known. Nephridial pores of the anterior segments are immediately below the c line of setae, while further back they are in the line cd . Male pores not known and setae of segment 18 all normal. Spermiducal glands open to the exterior in the line of the ventral pairs of setae. 2 pairs of spermathecal pores in furrows 7/8 and 8/9 immediately lateral to the a line of setae; ventral setae of segments 8 and 9 modified as genital setae, and are marked on the distal half by 4 irregular longitudinal

rows of low rounded scars. The distal tip is claw-like, swelling out slightly just before the point and marked by 2 longitudinal ridges. Septa 5/6-13/14 thickened. Gizzard in segment 5; mid-gut begins in segment 13. Last heart in segment 12. 2 pairs of sperm sacs in segments 9 and 12; spermiducal glands long and thread-like, irregularly twisted at the proximal end. Penial setae occur in segments 17 and 19. They are marked by scar-like grooves with irregularly-toothed distal margins. The distal end is irregularly bent and tapers to a sharp point. Spermathecae ampulla-shaped or sac-like, merging into the duct; a diverticulum with a sacculated lumen opens into the distal region of the ampulla.

No fully mature specimen has yet been examined. Length, 85mms.; diameter, 2mms.; number of segments, about 200.

Locality: Cannington, in swampy ground.

2. Genus *MICROSCOLEX* Rosa, emend.

8 setae per segment. Nephridial pores in a longitudinal line on each side. Male pores in segment 17 or 18. Pores of the spermiducal glands, 1 or 2 pairs in segment 17 or in 17 and 19. 1 or 2 (or 3?) pairs of spermathecal pores (exception, *M. dubius*) the last in furrow 8/9. Gizzard rudimentary or lacking (known only as a slight strengthening of the muscles of the gut visible in serial sections). 2 pairs of testes and seminal funnels projecting freely into segments 10 and 11.

Cape of Good Hope, Darien, Tierra del Fuego, South America, Falkland Is., Auckland Is., Antipodes Is., Campbell Is., Macquarie Is., New Zealand, Australia, Tasmania, Algiers, Canary Is., Madeira, Europe, North America.

1. *Microscolex dubius*. (Fletcher.)

In life a yellowish flesh-colour with a transparent skin; unpigmented. Head epilobous (?). Setae set far apart; setal distance $aa = 2ab$, $ab < cd$, $cd < bc$; ab is smaller near the male pores. Nephridial pores in line d in segments 2-4; further back they lie just beneath c . Dorsal pores lacking. Clitellum complete, covering segments 13-17; male pores between the a and b lines of setae. Septa 5/6-14/15 thickened. Gizzard rudimentary, in segment 5. Mid-gut without a typhlosole. Last heart in segment 12. 2 pairs of racemose sperm-sacs in segments 11 and 12; spermiducal glands with a very short duct. Penial setae 1mm. long, quite straight with a somewhat obliquely truncate distal point, ornamented with very delicate transverse lines. Spermathecae lacking.

Length, 45-70mms.; diameter, 3-5mms.; number of segments 85-120. Very common in South-West Australia.

Distribution: World-wide.

2. *Microscolex phosphoreus*. (Ant. Dug.)

Unpigmented and in life phosphorescent. Head epilobous ($\frac{1}{2}$). Setae far apart; setal distance $aa = 2ab = bc$, $cd < bc$, $dd = 2bc$. Nephridial pores of segments 2-4 in the d line of setae, further back they lie just beneath c ; dorsal pores are lacking. Clitellum complete, covering segments 13-16 or 17 (4 or 5 segments). Spermathecal pores in furrow 8/9; genital pores all in the a line of setae. Gizzard rudimentary; mid-gut without typhlosole. Last heart in segment 12. 2 pairs of sperm sacs in segments 11 and 12; penial setae slender and delicate, faintly bent, irregularly biset with small broad flattened teeth. Spermathecae with a short club-shaped diverticulum. Length, 10-35mms.; diameter 1-2mms.; number of segments, 75-90.

Locality: Cannington.

Distribution: World-wide.

SUB-FAM. MEGASCOLECINAE.

KEY TO THE GENERA OF THE MEGASCOLECINAE.

Spermiducal gland elongated and tubular, with a simple unbranched canal	{	Meganephridial...	{	8 setae per segment	{	Gizzard well developed	{	Male pores and spermathecal pores paired ...	1. <i>Plutellus</i> .
								Male pores and spermathecal pores unpaired...	8. <i>Fletcherodlus</i> .
								...	2. <i>Pontodrilus</i> .
								...	9. <i>Diporochas</i> .
Spermiducal gland with a branching canal system	{	Meganephridial...	{	At least in the middle and hinder part of the body (more than 8) setae per segment	{	Gizzard rudimentary	{	...	3. <i>Megascolia</i> .
								...	10. <i>Spenceriell</i> .
								...	4. <i>Woodward</i> .
								...	11. <i>Perionyche</i> .
								...	12. <i>Perionyx</i> .
								...	5. <i>Notoscolex</i> .
								...	13. <i>Digaster</i> .
								...	14. <i>Eidymogaster</i> .
								...	15. <i>Perissogaster</i> .
								...	6. <i>Megascolex</i> .
								...	7. <i>Pheretima</i> .
								...	16. <i>Pleonogaster</i> .

1. GENUS PLUTELLUS E. Perrier.

Eight setae per segment. Male pore paired. Spermathecal pores usually paired, 2-5 pairs, the last in furrow 8/9. One gizzard in the region of segments 5-7. Always meganephridial. Spermiducal gland long and cylindrical with a simple unbranched canal.

Australia, Tasmania, India, Ceylon, North America.

- | | |
|---|--------------------------------|
| 1. { Spermathecal pores unpaired ... | 11. <i>P. asymmetricus</i> . |
| 2. { Spermathecal pores paired—2. | |
| 3. { 2 pairs of spermathecal pores—3. | |
| 4. { 3 pairs of spermathecal pores—12. | |
| 5. { Spermathecae with a variable number of diverticulæ ... | 14. <i>P. varicostis</i> . |
| 6. { Spermathecae with a constant number of diverticulæ—4. | |
| 7. { Spermathecae with 1 diverticulum—6. | |
| 8. { Spermathecae with 2 diverticulæ—5. | |
| 9. { Penial setae with a simple point ... | 1. <i>P. termitophilus</i> . |
| 10. { Penial setae with a bifid point ... | 2. <i>P. wellingtonianus</i> . |
| 11. { Lumen of diverticulum of spermatheca asymmetrical ... | 3. <i>P. streltzi</i> . |
| 12. { Lumen of diverticulum of spermatheca symmetrical—7. | |
| 13. { Diverticulum of spermatheca containing sperm chambers—8. | |
| 14. { Diverticulum of spermatheca simple—9. | |
| 15. { Spermathecal duct sharply defined ... | 6. <i>P. mervaeensis</i> . |
| 16. { Spermathecal duct indistinct ... | 4. <i>P. woodwardi</i> . |
| 17. { Spermathecal pores in the <i>b</i> line of setae—13. | |
| 18. { Spermathecal pores medial to the <i>b</i> line of setae—10. | |
| 19. { Only median unpaired accessory glands occur ... | 8. <i>P. blackroodiana</i> . |
| 20. { Paired accessory glands occur ... | 11. <i>P. schumanni</i> . |
| 21. { Head epilobous ... | 9. <i>P. carpeus</i> . |
| 22. { Head pro-epilobous ... | 10. <i>P. levis</i> . |
| 23. { Spermathecae with distinct diverticulæ ... | 12. <i>P. ?</i> . |
| 24. { Spermathecae with basal lobes ... | |
| 25. { Glandular markings occur in the region of the spermathecal pores ... | 13. <i>P. candidus</i> . |
| 26. { Glandular markings do not occur in the region of the spermathecal pores ... | 7. <i>P. menditui</i> . |

1. *Plutellus termitophilus*, Michlsn.

Yellowish grey in the ante-clitellar and hinder regions, the middle body being a patchy green-gray due to the gut-contents being visible through the skin. Head epilobous. Setae wide apart, $aa = 2 ab$, $bc = 1\frac{1}{2} ab$, $cd = 1\frac{1}{3} ab$, $dd = 2aa = \frac{1}{3} u$; the ventral pairs narrow towards the male pore; setae of the hinder end irregularly arranged. First dorsal pore in furrow 6/7 though rudimentary pores occur in 5/6 or 4/5 and 5/6. Clitellum saddle-shaped and covering segments 14-17, but furrows, setae, and dorsal pores are visible in these 4 segments. Male pores in the form of fine slits of which the medial end reaches to the b line of setae; female pores immediately anterior to seta a , on transverse papillae united by a median bridge; 2 pairs of spermathecal pores in furrows 7/8 and 8/9 just above the b line of setae, conspicuous because on small papillae. Accessory glands in the form of oval transversely-elongated, intersegmental areas of which only the anterior and posterior borders are marked, and which bear tiny papillae. These areas are ventral-median and unpaired in furrows 12/13-16/17, the first 2 bearing 3 papillae, the rest 1 papilla each; paired and bearing 1 papilla in 17/18-21/22, the distance between them widening then narrowing again; median and unpaired and bearing 1 papilla in 22/23 and 23/24. Only the first 2 areas and those in 17/18-20/21 are constant. Septa 6/7-14/15 thickened. Gizzard in segment 5. Distinct calciferous glands lacking, but the dilatation in 16 has slight dorsal sacculations. 2 pairs of testes and seminal funnels projecting freely into segments 10 and 11 or embedded in free sperm masses; 2 pairs of sperm sacs in segments 9 and 12; spermiducal glands coiled, with a distinct s-shaped muscular duct. Penial setae delicate, irregularly curved, sharply pointed distally, and covered, except for the extreme end with moderately coarse scattered thorns. Spermathecae irregular and cylindrical opening directly to the exterior through a narrowing of the distal end; 2 elongated ampulla-like diverticula opening opposite each other into the narrowing distal end of the main pouch, while a third may be present, opening further up.

Length, 50-65mms.; diameter, 3-3½mms.; number of segments, 130-150.

Locality: Fernbrook (formerly Lunenberg), in the wall of a termite nest.

2. *Plutellus wellingtonianus*, Michlsn.

Colour, a dirty gray. Head epilobous. Setae set far apart anteriorly: $ab = \frac{1}{2} aa$, $bc = \frac{9}{10} aa$, $cd = \frac{5}{9} bc$, $dd = \frac{1}{3} u$; posteriorly slightly closer together. First dorsal pore in furrow 5/6; male pores in segment 18 on small transversely-oval papillae in the b line of setae; 2 pairs of spermathecal pores in furrows 7/8 and 8/9 in line b . The accessory glands are in the form of transversely-elongated intersegmental glandular fields, unpaired and ventral-median in furrow 18/19, paired and connected by ventral-median bands in 11/12, 12/13, 17/18, 19/20 and 20/21. Septa slightly thickened in the region of the testes. Gizzard in segment 6; oesophagus without calciferous glands. Last heart in segment 12. Two pairs of seminal funnels lying freely in segments 10 and 11; a pair of slender multi-lobed sperm sacs in segment 12. Spermiducal glands much twisted with a moderately short muscular duct as thick as the glandular region. Penial setae with a double bend at the distal end, irregularly beset with thorns, and with a tip which bifurcates into two widely divergent tips. Spermathecae long, sac-like, and irregularly bent, with a short sharply-defined duct; 2 small tubular diverticula open opposite each other into the distal end of the ampulla.

Length, more than 25mms. ; diameter, $1\frac{1}{2}$ –2mms. ; number of segments more than 68.

Locality : Collie, in moist rich earth.

Remarks : Only one much-damaged mature specimen, without a clitellum, and one immature specimen probably of the same species, were found

3. *Plutellus strelitzi*, Michlsn.

Body stout, unpigmented and grayish in colour. In life with a faintly pink head region ; clitellum orange. Head pro-epilobous, $aa = 2\frac{1}{2} ab$, $ab = \frac{4}{5} bc$, $bc \geq cd$. Setal line d slightly irregular : posteriorly the setae all become irregular. First dosal pore in furrow $4/5$. Clitellum saddle-shaped and covering segments 13–18. Male pores on narrow transversely-oval papillae in the b line of setae in segment 18 ; 2 pairs of spermathecal pores in furrows $7/8$ and $8/9$, slightly above the a line of setae. Accessory glands consist of very tiny paired linear papillae in furrows $16/17$ and $19/20$ in line a , often indistinct or lacking, sometimes 2 smaller pairs occur, in furrows $15/16$ and $20/21$. Septa $7/8$ – $11/12$ thickened, $6/7$, $12/13$ and $13/14$ very slightly so. A very large gizzard occurs in segment 5 ; oesophagus with a pair of large kidney-shaped calciferous glands in segment 17 ; mid-gut begins in segment 18. Last heart in segment 12. Two pairs of testes and seminal funnels in segments 10 and 11 embedded in free seminal masses ; a pair of large racemose sperm sacs in segment 12, and a tiny simple pair in segment 9 ; spermiducal gland with a very small duct ; penial setae curved in an arc with a backwardly-bent, flattened or slightly hollowed distal end which is constricted distally then widens again to two horns which form a small crescent across the top of the setae. The distal half of the setae is beset on the convex curve with tiny thorns. Spermathecae thick short and irregularly bent with a large leaf-like diverticulum opening laterally into the distal end of the duct ; the lumen of the diverticulum is lateral in position, giving out branches which extend across the width of the diverticulum.

Length, 50–65mms. ; diameter, 6–7mms. ; number of segments, 155–160,

Locality : Lion Mill, in moderately dry gravelly earth.

4. *Plutellus woodwardi*, Michlsn.

Colour, yellowish, or brownish-gray ; in life whitish, the head end faintly red. Head pro-epilobous (?) ; segment 1 with a longitudinal dorso-medial furrow. Setae : $aa = 3 ab$, $ab = \frac{1}{2} bc$, $bc = \frac{1}{3} cd$, $dd = \frac{1}{2} u$ (roughly) ; setal line d becomes irregular posteriorly. First dorsal pore in furrow $4/5$. Male pores in segment 18 on small oval papillae in setal line b ; 2 pairs of spermathecal pores in furrows $7/8$ and $8/9$ in setal line a ; Accessory glands in the form of indistinct glandular patches in the line ab in furrows $15/16$, $16/17$, $18/19$, and $19/20$, the last two pairs sometimes with ventral-median connections. Septa $3/7$ – $13/14$ thickened. Gizzard large, in segment 5 ; oesophagus without calciferous glands, but swollen in segments 16 and 17. Mid-gut begins in segment 18 and has a very small typhlosole. Last heart in segment 12. One pair of racemose sperm sacs in segment 12, and a small simple pair in 9 ; two pairs of seminal funnels projecting freely into segments 10 and 11 ; spermiducal glands thick and irregularly curved, and beset distally with thorns ; at the distal tip the seta is flattened at each side forming two lateral seams at right angles to the plane of the curve, which extend in front of the point, their junction being marked by a small notch. The main pouch of each spermatheca is stout, tubular, and irregularly bent, and is filled with a

granulated mass and several darker irregular bodies ; it merges into a short duct, the lumen of which is somewhat twisted ; the diverticulum, which opens distally into the duct, is thick and tubular, the proximal end swollen and somewhat lobed owing to the presence of 2 or 3 sperm chambers.

Length, 90–100mms. ; diameter, $4\frac{1}{2}$ –6mms. ; number of segments, 160–166.

Locality : Collie.

5. *Plutellus levis*, Michlsn.

Colour, clear gray. Head epilobous. Setae widely separated : $aa : 1\frac{1}{2}ab - bc = cd - \frac{1}{2}dd$. First dorsal pore in furrow 4/5. Clitellum saddle-shaped, covering segments 13–18. Male pores immediately ventral to the a line of setae on distinct oval papillae in segment 18 ; 3 pairs of spermathecal pores in furrows 6/7 – 8/9 in the a line of setae. No accessory gland known. Septa 9/10–12/13 faintly thickened. Gizzard in segment 6 ; oesophagus wrinkled and with a rich blood supply in segments 7–14, and in 14 with an annular sacculation which resembles a calciferous gland ; similar but smaller sacculations occur in segments 13, 12, and 11. Last heart in segment 12. 2 pairs of testes and seminal funnels in segments 10 and 11 ; 2 pairs of sperm sacs in segments 9 and 12, the foremost sac-like, the hinder racemose. Spermiducal gland closely coiled with a short narrow duct ; penial setae irregularly bent and very delicate ; the distal tip is flattened and rounded and the convex curve immediately below this tip is beset with tiny teeth which are extremely difficult to make out. The spermathecae are irregular, sac-like and flattened, merging into a short duct ; a small pear shaped diverticulum opens into the distal end of the ampulla ; a second still smaller diverticulum may occur, opening immediately below the first.

Length, 55mms. ; diameter, $2\frac{1}{2}$ mms. ; number of segments, 121.

Locality : Cannington.

6. *Plutellus murrayensis*, Michlsn.

Colour, a dirty yellow, or green-gray, the head region faintly brown or flesh-coloured. Head epilobous. Setae faintly ornamented distally. $ab : bc : cd : = 14 : 15 : 13$; $aa - ab + bc + cd$; $dd - \frac{1}{2}u$. First dorsal pore in furrow 5/6. Clitellum complete, but only slightly developed ventrally, covering segments 13–17. Male pores just below b , on oval papillae ; spermathecal pores, 2 pairs in the a line of setae in furrows 7/8 and 8/9. Indistinctly-bounded glandular pads occur in the ventral-median region of segments 8 and 9, a pair of oval papillae between lines a and b in segment 17, and unpaired long narrow thickenings ventral-median in furrows 19/20 and 20/21. Septa 8/9–11/12 faintly thickened. Gizzard in segment 5 ; oesophagus with a wrinkled vascular wall in segments 10–16, widening considerably in 16. Last heart in segment 12. 2 pairs of testes and seminal funnels in segments 10 and 11 ; 1 pair of simple sperm-sacs in segment 9, and 1 pair, compressed and racemose, in segment 12 ; spermiducal glands with an irregular and loosely wound glandular region and a distinct short duct. Penial setae long, delicate, and irregularly bent ; the distal end is flattened, with a convex terminal margin tipped by a tiny curved tooth ; with the exception of this flattened region the distal end is marked by two somewhat irregular, longitudinal rows of teeth. Spermathecae irregular and sac-like with a sharply defined duct, into which, half-way down its length, opens a sausage-shaped diverticulum containing 2 or 3 ill-defined sperm-chambers.

Length, 42–54mms. ; diameter, 2–3mms. ; number of segments, 109–114.

Locality : Jarrahdale.

7. *Plutellus mendilai*, Michlsn.

Unpigmented, a clear or a dirty gray due to the gut contents being visible through the body-wall. Head epilobous. Setae : $aa = \frac{5}{3} ab$, $ab = \frac{2}{3} bc$, $bc = \frac{3}{4} cd$, $cd = \frac{2}{3} dd$, $dd = \frac{2}{9} u$. First dorsal pore in furrow 4/5. Clitellum saddle-shaped, covering segments 13-17. Male pores in segment 18 on small indistinct papillae in the *b* line of setae ; female pores apparently on a glandular wall extending from *a-a* in segment 14 ; spermathecal pores, 2 pairs in furrows 7/8 and 8/9 in the *b* line of setae. 4 pairs of transversely elongated thickenings deeply cut by the intersegmental furrows in 11/12, 12/13, 20/21, and 21/22 in the line *ab*. Septa 6/7-10/11 moderately thickened. Gizzards in segment 6 ; oesophagus thick, swollen, and longitudinally striped in segment 16, the internal structure resembling that of a calciferous gland ; mid-gut begins in segment 17, and is broad with a distinct typhlosole. 2 pairs of testes embedded in free seminal masses in segments 10 and 11 ; 2 pairs of large sperm sacs in segments 9 and 12, the former simple, the latter multi-lobed. Spermiducal glands in segment 18, or in 17 and 18, with a thick coiled glandular region and a short s-shaped duct. Penial setae delicate and curved, the distal end flattened, slightly widened, truncate and curved at the sides so as to resemble a spatula or a scoop. Spermathecae with a large irregular sac-like ampulla about 3 times as long as the duct ; a thick club-shaped diverticulum opens about half-way down the duct.

Length, 30-35mms. ; diameter, 2-2½mms. ; number of segments, 78-98.

Locality : Eradu.

8. *Plutellus blackwoodianus*, Michlsn.

Colour, a dirty white, the gray gut-contents, nephridia, and spermiducal glands being visible through the skin. Head epilobous. Setae wide apart anteriorly, closer together posteriorly : anteriorly $aa : ab : bc : cd : dd = 14 : 6 : 12 : 9 : 27$; posteriorly, $aa : ab : bc : cd : dd = 9 : 6 : 7 : 7 : 14$. First dorsal pore in furrow 6/7. Male pores in segment 18, apparently in the *a* line of setae ; 2 pairs of spermathecal pores in furrows 7/8 and 8/9 apparently medial to line *a*. Oval, ventral-median glandular fields each bearing a small central papilla occur in furrows 12/13, 16/17, and 19/20. Septa in the testes-region slightly less delicate than the rest. Gizzard in segment 6 (?) ; oesophagus without calciferous glands. 2 pairs of testes and seminal funnels in segments 10 and 11 ; 1 pair of sac-like sperm sacs in segment 12 (a second pair further forward ?) ; spermiducal glands long and coiled, the coils becoming tightly pressed together towards the duct, which is short and narrow. Penial setae curved, gradually tapering distally ; the distal end is flattened and slightly wider, with an uneven outline ; except for the flattened region the setae are beset with irregular rings of teeth. Spermathecae with a sac-like ampulla merging into a duct which narrows distally ; the diverticulum opens into the distal end of the ampulla.

Length, 18-28mms. ; maximum diameter, 1.3mms. ; number of segments, 90-95.

Locality : Bridgetown.

9. *Plutellus schumanni*, Michlsn.

Colour, yellowish-white, the gray gut-contents visible through the skin ; in life the worm has a reddish tint. Head epilobous. Setae set very wide apart : $aa = 2ab$, $ab = \frac{2}{3} bc$, $bc \geq cd$, $dd = 2aa$. Dorsal pores occur but are indistinct. Clitellum complete but thinner in the ventral-median line,

covering segments $\frac{1}{3}$ 13 or 14-17. Male pores on oval papillae in segment 18, between the *a* and *b* lines of setae; 2 pairs of spermathecal pores in furrows 7/8 and 8/9 slightly lateral to line *a*. Two pairs of large ventral-median oval areas with raised margins and sunken centra in furrows 13/14 and 14/15; 2 or 3 pairs of papillae in the anterior regions of segments 19 and 20, or 19, 20, and 21, the hindmost between lines *a* and *b*, the others slightly more lateral; these papillae are connected in pairs by a ventral-median glandular field in each segment. Septa 6/7-13/14 thickened. Gizzard in segment 6; oesophagus swollen in each segment but without calciferous glands. 2 pairs of irregular sperm sacs in segments 9 and 12; 2 pairs of seminal funnels in segments 10 and 11; spermiducal glands with a very thick coiled glandular area somewhat flattened by the pressing together of the coils, and a sharply-defined short bent duct. Penial setae lacking. Spermathecae with a pear-shaped ampulla the proximal swollen end of which is bent to the side; the ampulla narrows distally to the duct which is extremely small and entirely hidden in the body-wall; a simple diverticulum opens into the distal end of the ampulla.

Length, about 40 mms.; maximum diameter, 2-2½ mms.; number of segments, about 120.

Locality: Albany.

10. *Plutellus carneus*, Michlsn.

Colour, white and unpigmented, in life flesh-pink. Head pro-epilobous. Setae wide apart: $aa - 2 ab = bc - \frac{4}{3} cd - \frac{2}{5} dd$. First dorsal pore in furrow 6/7; male pores on oval papillae the centra of which are practically in the *b* line of setae; 2 pairs of spermathecal pores in furrows 7/8 and 8/9 in the *a* line of setae. Paired oval papillae occur in furrows 10/11, 16/17, 17/18 and 18/19, nearly between the *a* and *b* lines of setae. Septa 5/6-11/12 thickened. Gizzard small, in segment 5; oesophagus simple, without calciferous glands, 2 pairs of seminal funnels in segments 10 and 11; 1 pair of racemose sperm sacs in segment 12; spermiducal glands with an irregularly coiled glandular region about 8-10 times as long as the duct. Penial setae lacking. Spermathecae with a long sac-like ampulla merging into a short duct which is entirely hidden in the body-wall; the diverticulum is simple and opens into the distal end of the ampulla.

Length, 90 mms.; maximum diameter, 3 mms.; number of segments, about 190.

Locality: Albany.

Remarks: Only one specimen of this worm has been found.

11. *Plutellus asymmetricus*, Michlsn.

Head epilobous. Setae wide apart: $aa - \frac{3}{2} ab = \frac{4}{3} bc - \frac{4}{3} cd$; $dd = \frac{4}{3} = \frac{4}{7} u$. First dorsal pore in furrow 5/6. Clitellum complete, covering segments 14-17. Male pores indistinct in segment 18 (in line *a* of setae?); 2 unpaired ventral-median spermathecal pores in furrows 7/8 and 8/9. Elongated ventral-median glandular fields, extending almost to the *b* line of setae on each side, occur in segments 13, 14, 16 and 18 or only on 13 and 18; the margins of these fields, or only the lateral margins and those distal to the male pores, are thickened and glandular and the centrum of each field is marked by a tiny papilla. Septa 9/10-11/12 moderately thickened. Gizzard in segment 6 (?·5?); oesophagus simple and sacculated

segmentally, without calciferous glands. Last heart in segment 12. 2 pairs of seminal funnels in segments 10 and 11 ; 3 pairs of irregular sac-like sperm sacs in segments 9, 11, and 12 ; spermiducal glands large and tightly coiled with a very short delicate duct. Penial setae apparently lacking. Spermathecae unpaired ; the ampulla is sac-like, irregular, and doubled over, the distal part fairly distinct and narrower (duct ?) ; the diverticulum contains 2 sperm chambers the division between which is marked externally by a notch, and opens into this narrow region of the ampulla.

Length, 27–35 mms. ; diameter, 2–2 $\frac{3}{4}$ mms. ; number of segments, 95–106.

Locality : Albany.

Plutellus sp. Michlsn.

Locality : Dongarra.

Remarks : Only one specimen was found, and this differed from all known species, but unfortunately it was lost. It is mentioned because it was found further north than any other *Plutellus*.

12. *Plutellus dalgarangae*, Sp. nov.

Two immature specimens of *Plutellus* were found under rocks on a hill-side at Dalgaranga Station, east of Yalgoo. The larger measured 45 mms., and was slightly less than 2 mms. in thickness, consisting of 92 segments. The worms are of a creamy flesh-colour, the contents of the gut showing through the body-wall and imparting a gray tinge. There are three pairs of spermathecae widely set in segments 7, 8, and 9, opening to the exterior at intersegments 6/7, 7/8, and 8/9. They are ampulla shaped and merge gradually into the duct. There is no diverticulum but on either side of the base of the ampulla is a swelling larger, more distinct, and rather more proximally placed on one side than on the other. A pair of developing sperm sacs was seen in segment 12. There is a moderately large gizzard in segment 5 and in segment 14 the wall of the oesophagus is divided longitudinally into a number of lobes having a rich blood supply.

It is not possible without further material to give a more detailed description, but the species is evidently a new one, for though it resembles *Plutellus levis* Michlsn in the structure of the oesophagus in segment 14 and also in having 3 pairs of spermathecae, these spermathecae are of a different type and the gizzard occurs a segment earlier. Also the specimens were found further north in a much drier region.

Michaelson notes as an interesting fact that he found a *Plutellus* (the species of which he was for reasons stated unable to determine) as far north as Dongarra. The two specimens from Yalgoo, however, were still further north and much further inland.

13. *Plutellus candidus*, Sp. nov.

Pl. XV. Figs. 9, 12, 13. Text-fig. 6.

External features : Length, 100 mms. ; breadth, 5 mms. ; number of segments about 140.

In life the worm is colourless and unpigmented, though the red blood, which is visible through the skin, gives it a somewhat pinkish tinge. After preservation in alcohol it becomes white and opaque.

Each of the segments of the body, from number 7 onwards, is marked by two annuli which divide it into three approximately-equal bands, the setae being borne on the middle band. In segment 6 the second annulus is incomplete, while in segment 5 only one occurs, the setae being borne on the broader posterior band. Segments 1-4 have no annuli at all. Posterior to the clitellum the annuli are faint, but in the clitellar region they are deeply marked and make it extremely difficult to distinguish the segments.

The head is prolobate and the peristomial segment has a mid-dorsal longitudinal groove. This groove has a very small anterior bifurcation which encroaches on the prestomium.

The setae are very difficult to see, owing to the whiteness of the body, but they appear to be fairly widely set.

The first dorsal pore lies between segments 5 and 6.

The clitellum is distinct and saddle-shaped, covering segments 13-17, extending ventrally as far as the *b* line of setae.

The male pores could not be distinguished, but they presumably lie in the papillae which extend between the *a* and *b* lines of setae on each side of segment 18. Judging by the position of the duct of the spermiducal gland as seen in the dissection and by the fact that the papillae mentioned are somewhat thicker and more pronounced on the outer side, it would seem that the pores are either in or very close to the *b* line of setae.

The female pores have very slightly thickened lips and can be seen between and slightly in front of setae *a*, *b*, in segment 14.

The spermathecal pores are also indistinguishable. Dissection shows that there are two pairs lying in or near the *b* line of setae at intersegments 7/8 and 8/9.

The accessory glands consist of a pair of circular glandular papillae in setal line *b* at intersegment 16/17 and a pair of tiny and almost contiguous glandular patches in an elongated ventral-median papilla at intersegment 18/19. The posterior third of segment 17 is thickened transversely to form a sort of ridge and the two ventral pairs of setae in segment 19 are prominent, as if borne on tiny papillae. Anteriorly there are two pairs of oval glandular patches in setal line *b* on the hinder border of segments 7 and 8 projecting backwards so as to lie partly in the next segment, and an oval ventral median patch on the anterior border of each of segments 8 and 9.

Anatomy : Septa 7/8-12/13 are slightly thickened, the strongest being 9/10-11/12.

Gut : The gizzard, which is small and not very strong-walled lies in segment 5. The entire oesophagus has an extremely rich blood supply, and in segment 16 it is swollen, rounded, somewhat paler, and very smooth. Since there was only one specimen upon which to work this swelling was not sectioned, but its structure is probably that of a calciferous gland though its outer walls are much smooother than is usual with the calciferous glands of other species of the genus. The mid-gut begins in segment 18.

The last heart is in segment 13.

Meganephridia are present, occurring first in segment 13.

Neither testes nor spermiducal funnels were seen but there are probably two pairs in segments 10 and 11 since both of these segments contained free sperm masses. There is one pair of sperm sacs projecting from septum 11/12 into segment 12. These sacs are broken up so as to appear like a mass of

small sacs closely pressed together. The spermiducal glands are long and cylindrical and occupy segment 18 with one loop projecting forwards into segment 17. The muscular duct is much narrower and moderately long. Penial setae are present. The sac containing them was removed from one side of segment 18 where it opens side by side with the duct of the spermiducal gland. The sac itself was very long and thread-like and in it were three slender, delicate and apparently fairly pliable penial setae. These setae are evenly curved and have a slight bend at the extreme distal point. The distal third is beset with small spines arranged in rows encircling the setae and becoming scantier and more scar-like proximally. Two of the setae project from the sac, and these two measure 2.5 and 2.6 mms. respectively, being proximally .03 and distally .01 mm. in diameter. One of these has a slight nodule at a point about two-fifths of its length measured from the proximal end and this same seta has a somewhat undulating surface towards its base. The other has no nodule but there is a slight swelling about half way along it. The third seta is not so well developed and lies further back in the sac. It is shorter, being only 2.2 mms. in length, the spines are little more than small scars and a faintly striated core is visible. Like one of the other two setae the wall of the base is undulating but the undulations are longer and extend further along it.

The female organs are normal in position, the ovaries being large and rather bushy.

The spermathecae are extremely large and sac-like with a short indistinctly defined duct and a large, also sac-like diverticulum which is about three-quarters as long as the main body of the spermatheca.

Locality : Roleystone.

Remarks : Only one specimen of this species was found and that was examined by dissection. It appears to be a normal *Plutellus* except that the last heart lies in segment 13. The position of the last heart is not a generic character, but in most species, certainly in all of those recorded previously from West Australia, it is in segment 12.

14. *Plutellus varicystis*. Sp. nov.

Pl. XV. Fig. 4. Text-figs. 7, 8.

External features : Length, 63 mms., diameter, 2.5 mms. These measurements were taken after the specimens had been preserved in alcohol. There are, roughly, 120 segments in the body.

The worms were not seen alive, but after preservation they were flesh-coloured, some with a brownish tinge.

The head is epilobous.

The setae are rather stout and fairly evenly arranged, *d* being slightly dorsi-lateral. There are no penial setae, the two ventral pairs being missing entirely from segment 18.

The clitellum is saddle-shaped, covering segments 14-17. It is inconspicuous, and only occurred on a very few of the specimens obtained.

Dorsal pores occur from furrow 5/6 onwards, but are lacking in the clitellar region, that is, from (14/15?), 15/16, and 16/17. These pores were lacking even in the individuals in which no clitellum could be distinguished.

No pores are visible on the ventral surface, even with the aid of a lens. Segment 18 is marked ventrally by a pale oval patch which extends laterally to the *b* line of setae on each side ; as noted above, there are no ventral setae

on this segment. It is difficult, even by examining serial sections, to determine the exact position of the male pore. The duct of the spermiducal gland enters the body wall in line with the *b* setae, but then appears to curve in a ventral direction, opening somewhat medial to this line.

Accessory glands occur in the form of small rounded papillae, one pair just medial to the *b* line of setae between segments 11 and 12, and another pair in the same position between segments 16 and 17. A median unpaired papilla also occurs in furrow 16/17.

Serial sections also show that the spermathecal pores lie in the *a* line of setae in furrows 7/8 and 8/9.

Anatomy: Septa 6/7–11/12 are slightly thickened.

The gizzard, which is large and well formed, is in segment 6. The oesophagus has no lateral calciferous glands, but vascular folds of the wall project into the lumen in the manner usually associated with these glands.

The last heart is in segment 12.

The male genital organs consist of two pairs of testes and seminal funnels projecting freely into the body cavity in segments 10 and 11; two pairs of sperm sacs projecting from septa 9/10 and 11/12 into segments 9 and 12; and a closely coiled tubular spermiducal gland with an extremely short muscular duct.

There are two pairs of spermathecae which seem to show a good deal of variation in structure. The main pouch is ampulla-shaped but it may be slender or stout, and bears, usually, two slender diverticula, each with a terminal chamber. Often, however, only one diverticulum is present, or so many as three may occur. The number of these diverticula appear to differ even in spermathecae of the same individual.

Locality: The Porongorups.

2. GENUS PONTODRILUS, E. Perr.

8 setae per segment. Male pores paired. Spermathecal pores, 2 or 4 pairs, the last in furrow 8/9. Gizzard rudimentary. Always meganephridial. Spermiducal glands tubular with a simple unbranched canal.

On the ocean shore. Southern France, Bermudas, Florida, West Indies, Brazil, West Mexico, lower California, Hawaii, Japan, Chatham Is., Loyalty Is., Celebes, Aru Is., Christmas Is., India, Ceylon, South-West Australia.

Pontodrilus albanyensis, Michlsn.

Colour, yellowish-gray and unpigmented. Head epilobous. Setae not distinctly ornamented, apparently without ornamentation: $aa = 2ab$, $ab = \frac{2}{3}bc$, $bc = \frac{5}{3}cd$, $cd = \frac{2}{3}dd$. Dorsal pores lacking. Male pores in segment 18 on small medially-inclined papillae in the *b* line of setae; spermathecal pores 2 pairs in furrows 7/8 and 8/9, also in the *b* line. Accessory glands consist of 1 pair of small oval papillae between the setal lines *a* and *b* in furrow 18/19, and 2 unpaired ventral-median spindle-shaped papillae in furrows 17/18 and 18/19. Septa 5/6–13/14 thickened. Gizzard rudimentary in segment 5. 2 pairs of testes in segments 10 and 11; 2 pairs of racemose sperm sacs in segments 11 and 12; spermiducal gland closely coiled with a short narrow twisted duct. Penial setae do not occur. Spermathecae with an irregular sac-like ampulla merging into the duct; a tubular diverticulum opens into the duct.

Locality: Albany, Nornalup, and Herring Bay.

Pontodrilus albanyensis, Michlsn var. *cygni* var. nov.

Plate XIV., Figs. 2, 3, 4, 9.

1907. *Pontodrilus albanyensis*, Michaelsen : *Die Fauna Sudwest Australiens* Band I., Lieferung 2. p. 185. Pl. II., Fig. 26.

External features : Length, 140 mms. ; diameter, 3 mms.

The worm is colourless, but with a red tint due to the blood in the vessels being visible through the skin.

The head is slightly epilobous.

The setae are ornamented, but the ornamentation, which consists of rows of very numerous and very fine teeth, could only be distinguished with the oil immersion lens. The setal distance *ab* is less than *cd*, and *d* is dorso-lateral, almost dorsal in position. There is no clitellum, but after preservation the more mature specimens show a slight constriction covering segments 13-18.The male pores are in segments 18 in papillae which lie in the *b* line of setae. The spermathecal pores are also in line *b* between segments 7-8 and 8-9.The accessory glands consist of a pair of tiny papillae lying in furrow 18/19 sometimes appearing to be on the posterior margin of 18, between the *a* and *b* setae on each side, and four transversely oval papillae in the ventral-median line in furrows 17/18, 18/19, 19/20, and 20/21.

Anatomy : Septum 13/14 is the last to show any traces of thickening.

A rudimentary gizzard occurs.

The nephridia, are large and distinct and may be seen clearly through the body-wall. They first occur in segment 15, though a small, feebly developed pair may occur in segment 13.

The male genitalia consists of two pairs of somewhat filamentous testes, their corresponding funnels projecting into the body-cavity in segments 10 and 11. Racemose sperm-sacs project from septa 10/11 and 11/12 into segments 11 and 12. There are also two tiny fan-like projections of the anterior septum into segment 14, which are suggestive of rudimentary sperm sacs. The spermiducal glands which occupy segments 18 and 19, are tubular and tightly coiled, with a muscular duct which is equal in diameter to the glandular region, but is distinct because almost straight.

The spermathecae consist of an elongated ovoid sac merging into a duct from the proximal end of which a tubular diverticulum, about half as long as the sac, is given off.

Locality : The bank of the Swan River, at Claremont. May, '27.

Remarks : Numerous specimens were obtained by digging in the sandy bank to a depth of 6-12 inches, when water was reached. This water was fresh, but the worms, like the majority of the Pontodrilids, seem quite able to stand the salt water of the river itself.

These specimens closely resemble *P. albanyensis*, differing only in size and the presence of two extra papillae on the ventral surface. The shape of the spermatheca is rather more regular, and the spermiducal gland more tightly coiled.

On two other occasions specimens of this variety have been collected. In November, 1925, a number were taken at Nornalup Inlet, in brackish water at the outlet of a spring, but the worms when examined later were found to be so badly preserved that very few features could be determined with accuracy. There was, however, a clitellum covering segments 14 to 18. In May, 1927, further specimens were obtained from the same locality. These all proved to be immature and lacked clitella, but they agreed in the type of spermathecae with the badly preserved specimens previously collected. In life their colour was similar, but in alcohol they differed slightly, being flesh-

coloured as against a dirty yellow, but all caused the same yellow discolouration of the preserving fluid. The immature individuals appeared to agree with *P. albanyensis* var. *cygni* described above, though in no case were all four accessory glands developed. In the majority they were lacking entirely, but that in furrow 17/18 was present in a few cases appearing more often to occupy the anterior midventral margin of segment 18, and in one specimen the lateral papillae between *a* and *b* in 18/19 and the mid-ventral papillae in 18/19 and 19/20 were also present. This same individual showed a narrow transverse ridge across the ventral surface of segment 14. The only other difference lay in the head, the epilobous condition being much more distinct than in var. *cygni*, and in the nephridia which were small but quite well developed in segment 13.

If the specimens first collected are of the same species as the others, as appears to be the case, it would seem to indicate that the clitellum is only developed during certain months, for it is entirely lacking in the specimens obtained from the Swan River in May, '27, which specimens are in all other respects apparently mature. It is probable also that the glandular region of the spermiducal gland become more swollen, and so more distinct during these months.

In Plate XIV. drawings of the spermatheca and spermiducal gland of *P. albanyensis* Mchlsn. are included for the sake of comparison.

Pontodrilus bermudensis, Bedd. forma *ephippiger*, Rosa.

Colour, deep yellow, Setae: *aa* — 2*ab*, *ab* : *bc* = *cd* (approx.), *dd* — 3 *cd*; *bc* becomes larger anteriorly. Clitellum saddle-shaped covering segments 13–17. Male pores in the *b* line of setae in segment 18, on the medial side of lateral swellings and at each end of a ventral median groove; a transverse ventral median sucker-like groove occurs in furrow 19/20. Spermathecal pores in the *b* line of setae. Septa 9/10 12/13 thickened. Gizzard unknown. Two pairs of testes and seminal funnels; 2 pairs of sperm sacs in segments 11 and 12; spermiducal gland with a distinct forwardly-curving duct and a twisted glandular region. Spermathecae with a slender tubular diverticulum that may be longer than the ampulla.

Length 43–47 mms.; diameter 3 mms.; number of segments 85–100.

Locality: Cottesloe and Denham.

Distribution: Christmas Island, Celebes (Pare-Pare), Hawaii (Laysan).

Remarks: This species was recorded from Denham in 1905 by Michaelson, but he made no further remarks concerning it. It may, therefore, be concluded that the specimens collected agreed with his original description of the species as given above. Five specimens, only two of which were mature, have since been found entangled in balls of weed at the water's edge at Leighton and Cottesloe, and these differ in one or two characters: in neither of the two apparently mature specimens was there a clitellum developed; both had a second pair of papillae on segment 18, medial to the lateral longitudinal walls (in one case these papillae were large and merged into the lateral walls, giving the effect of one large cleft papilla on each side; in the other case they were small, the condition thus being similar to that in the same species as described by Stephenson from Chilka Lake); the transversely oval papilla between segments 19–20 was only faintly developed; and there was in one case a thickened ridge along the anterior ventral margin of segment 14. The spermathecae were similar to those in the specimen from Chilka Lake, described by Stephenson (1914) having a diverticulum opening not to the duct but to the external surface close to the opening of the main pouch.

The chief difference lies perhaps in the fact that the setae are ornamented, but the ornamentation is slight and not constant. Smooth simple

setae are to be found as well as notched forms, such as are figured on Plate XIV., Fig. 6.

The largest specimen measured 85 mms. in length, with a diameter of 2 mms., and showed 97 segments.

Discussion on the genus *PONTODRILUS*, E. Perrier.

The following definition of the genus is given by Michaelsen in *Das Tierreich* 10 Lieferung, page 179 :—

“Borsten zu 8 an einem Segm. Gürtel mit oder vor dem 14 Segm. beginnend, über 5/6 Segm., 1 Paar weibliche Poren ; 2 Paar Samentaschenporen auf Intsegmtf. 7/8 und 8/9. 1 rudimentärer Muskelmagen vor den Hoden-segm., oder kein Muskelmagen. Meganephridisch ; Nephridien vor der Gürtelregion fehlend. 2 Paar freie Hoden und Samentrichter ; 2 Paar Samensacke im 11 und 12 Segm. ; Prostaten Schlauchformig ; die Samenleiter münden in den Ausführungsgang oder in den Drusenteil der Prostaten ein.”

This definition must be modified slightly in order to include a species which has been described since the publication of *Das Tierreich*. *P. agnesae* Stephenson, which has been recorded from India and Ceylon, has two pairs of sperm sacs projecting from septa 9/10 and 11/12 into segments 9 and 12.

A revised definition might read :—8 setae per segment ; clitellum begins with or before segment 14 and covers 5 6 segs. ; 1 pair of female pores ; 2 pairs of spermathecal pores in furrows 7/8 and 8/9 ; gizzard rudimentary, occurring before the segments containing the testes, or lacking ; meganephridial ; nephridia lacking in the antecitellar region ; 2 pairs of testes and funnels projecting into the body cavity ; 2 pairs of sperm sacs ; spermiducal gland ampulla-shaped ; vas deferens open into the duct or into the glandular region of the spermiducal gland.

Twelve different species and two varieties have at various times been assigned to the genus *Pontodrilus*, but marked similarities have led eventually to a recognition of the identity of some of them.

From the study of a table compiled from the descriptions (specimens being available in three cases only) of these thirteen species it would seem that the genus as it now stands includes a number of forms regarded as specifically distinct, but which are so closely related as to warrant a further reduction in their number.

Identification has been based on various characters some of which on investigation show an inconstancy that deprives them of importance.

For example : —

- (1) The setal distances. In this case allowance must be made for inequalities in shrinkage during fixation. The formulae, unless very distinctive, are, therefore, scarcely of diagnostic value.
- (2) The occurrence of thickened septa. Stress has often been laid upon this character, but it is now generally agreed that the importance of the extent of these septa is subordinate to other features.
- (3) Glandular markings. These are certainly different in each species as originally described, but they also appear to vary in individuals. Several cases of this inconstancy in individual members of a species may be mentioned

(a) Stephenson (1914), in his remarks on *ephippiger* Rosa as found at Chilka Lake, states :—“The genital markings are variable. (1) Most constant is one in 19/20, of an oval shape with long axis transverse ; its extent varies between setae *a* and *a*, or between *b* and *b* ; the form it takes also varies : (a) It may be a depression, with a well-marked lip-like margin,

and thus somewhat sucker-like ; (b) or a broad white low papilla with a flat surface ; (c) or a whitish well-defined area, but not raised above the general surface ; or (d) it may be very inconspicuous, though never, so far as I observed, entirely absent.

"The next commonest genital mark is (ii) a similar oval area in furrow 12/13, of whitish colour, stretching from between lines *a* and *b* on one side to a corresponding point on the other. This has the form of a low flat papilla ; it was present, though not always equally well-marked in about half the specimens examined. (iii) In one case there was a slight whitish, ill-defined elevation in the situation of groove 13/14."

Stephenson's specimens of *P. bermudensis* Bedd var. *ephippiger* Rosa differ from those found by Rosa in the presence of papillae on 12/13 and 13/14 and in the nature of the marking on 19/20. They also differ slightly in the setal distance *dd* and in the shape of the spermatheca.

This species as found at Cottesloe also varies ; one individual showed a thickening of the anterior ventral margin of segment 14 which was lacking in the other. In neither individual was there a papilla in 12/13.

(b) Beddard (1903) makes similar remarks concerning *P. laccadivensis*. He says : "I have studied 13 fully mature examples of this species, all of which show some of the ante-clitellar papillae which distinguish this species from all other *Pontodrilus* except Michaelsen's variety.* These papillae are not, however, equally or similarly developed in all. In seven examples there are two papillae plainly visible ; one lies between segments XII/XIII, and is, as a rule, much more conspicuous by reason of its convexity than the second papilla, which is *not* intersegmental in its position. It lies on XIV, though near to the anterior margin of that segment and not between XIII/XIV. In six individuals one or the other of these papillae was missing. In the last individual the two papillae were between XI/XII and XII/XIII, and both were of the same character. I may observe that the papilla upon segment XIV and that upon segments XII/XII occasionally showed considerable traces of being double. In no individual did I find a papilla between XIV/XV such as is mentioned by Michaelsen in his description of *P. Matsushimensis* var. *chathamiana*. In addition to these there are, as Michaelsen has pointed out, others situated more anteriorly still."

(c) *P. albanensis*, Michaelsen may serve as a third example. This was described by Michaelsen (1905) as having one small oval papilla in furrow 18/19 between setae *a* and *b*, and two unpaired ventral-median papillae in furrows 17/18 and 18/19. Numerous specimens of this species were collected by the writer at Nornalup Inlet, on the South-West corner of Western Australia, and it was found that though the marking was fairly constant in mature specimens, it was often very indistinct, and in several cases one or other of the papillae was missing. A small additional papilla occurred in furrow 19/20 of one specimen.

(d) Similarly with the new variety *cygni* there are usually four, but occasionally only three unpaired ventral-median papillae. An examination of specimens obtained later from Nornalup showed that 1, 2, 3, or 4 papillae may occur. As most of these specimens were young it would seem that immaturity may account for this apparent variation, the papillae developing not all at once but in turn, that in 17/18 appearing first. Two specimens however showed a transverse thickening on the ventral surface of segment 14, which was lacking in all the others.

Stephenson (1914) makes similar comments on the subject. He remarks on the variability of the species and adds *ephippiger* Rosa and

* *P. matsushimensis* Iizuka, var. *chathamiana*, Michlsn.

laccadivensis Bedd. to the three species already recognised as identical by Michaelsen, i.e., *bermudensis* Bedd., *insularis* Rosa, and *arenae*, Michaelsen. He also puts forward as a debatable matter the importance of the muscular duct of the spermiducal gland. This duct is distinct in every species with the exception of *matsushimensis* Iizuka and *agnesae* Stephenson. In *matsushimensis*, however, the male genital area in segment 18 is of the typical *ephippiger* type, which fact casts some doubt on the importance of the condition of the duct, especially when consideration is given to the fact that in one case at least (*P. albanyensis* var. *cygni* var. nov.) the duct is equal in diameter to the glandular region and distinguishable only by virtue of being nearly straight. It must be admitted that this may be due to slight immaturity, since specimens of *P. albanyensis* Michaelsen have been examined in which these two diameters were equal, while in others the glandular region was considerably swollen.

In the following table species with a similar male genital area have been placed together. The data was obtained in the cases of *insularis* Rosa, *arenae* Michlsn., *matsushimensis* Iizuka, *ephippiger* Rosa, *litoralis* Grube, *michaelseni* Eisen, and *hesperidum* Beddard from Michaelsen's "Das Tierreich" Lief 10; the rest was taken from the original descriptions, with an addition in the case of *albanyensis* Michlsn. concerning the position of the first nephridia, which was noted from specimens dissected by the writer.

This arrangement adds *matsushimensis* Iizuka to the group compiled by Stephenson, and this perhaps is to be desired since its resemblance to *laccadivensis* Bedd. has been commented on by Beddard (1903). This species stands rather apart, however, from the rest, being the only species lacking a distinct duct to the spermiducal gland, also the only species in which the clitellum completely encircles the body.

The advantage of setting out the original descriptions of species now recognised as identical lies in the fact that it shows that the distinction between other species is equally fine. They are all strikingly similar except in the male genital area, and even here the lateral walls of the group mentioned above, the medially-inclined papillae of *albanyensis* Michaelsen, the erect papillae of *albanyensis* Michlsn. var. *cygni* var. nov., the absence of papillae in *hesperidum* Beddard, and the depressed areas in *crosslandi* Beddard seem to form a connected series; and the second pair of papillae of *bermudensis* Beddard, forma *ephippiger* Rosa as found at Chilka Lake and Cottesloe suggests a link between that species and *michaelseni* Eisen.

This arrangement is also suggested by the position of the first nephridia, which occur, usually though not always, in segment 13 in the *bermudensis* groups and in *michaelseni*—which fact again suggests a connection between these two species; are reduced in size in segment 13 and missing in segment 14 in *albanyensis*; and lie in segment 15 in *crosslandi*.

The two species *litoralis* Grube and *agnesae* Stephenson are distinct, the former in that the pores are all in the *a* line of setae, the latter in that the sperm sacs are in segments 9 and 12. With these two exceptions there is a remarkable similarity between all the species of *Pontodrilus* which makes identification somewhat difficult.

In view of the lack of actual specimens of all but a few species, this discussion of the genus cannot lead to any definite statement, but it may serve to show that when a revision of the genus *Pontodrilus* is undertaken the chief point for consideration must be whether species are to be established on an aggregation of minor points, or whether the example of Michaelsen and Stephenson is to be followed, species hitherto considered distinct being recognised as local varieties of a few very widespread and very variable species.

Pontodrilus.	Colour.	Head.	Setae.	Spermathecal Pores. Line of Setae.	Spermathecae.	Thickened Septa.	Gizzard.	Sperm Sacs. Segments.	Male Pores. Segment 18.	Accessory Glands.	First Nephridia. Segment.	Duct of Spermiductal Gland.	Clitellum. Segments.	Dimensions. mm.	Number of Segments.	Distribution.
<i>bermudensis</i> ...	...	...	Slightly ornamented	<i>b</i> on conical papillae	...	...	Rudimentary	...	...	Raised oval area in anterior-ventral region of seg. 14. Unpaired ventral-medial papillae in furrows 12/13 and 19/20	...	Distinct	...	L 32-65 D 2-21 (India) L 100-120 D 3-34 (Burma)	100-120	Bermuda, Bahamas, India, Burma.
<i>malabaricus</i> ...	Brown	Prostomium without a dorsal extension	Ornamented: $ab < bc < cd$; $dd \leq 2cd$; $aa \leq 2ab$	<i>b</i>	Ampulla-shaped without a diverticulum	6 7-12 13	Rudimentary in seg. 7	11 and 12	On medial margin of longitudinal walls between <i>b</i> and <i>c</i> . A median pit extends between these walls	...	13	Distinct	...	L 50 D 3	100 (ca.)	Aru Is., Ceylon.
<i>agnesae</i> ...	Clear grey with a faint violet tone	Epilobous $\frac{1}{2}$	Ornamented: $aa > ab < bc < cd$; In clitellar region: $aa \approx ab$, $bc \approx cd$; Anteriorly: $dd \approx 3bc < cd$; Posteriorly: $dd \approx 1\frac{1}{2}aa$	<i>b</i>	Slender ampulla-shaped diverticulum opening into the distal end of the long thin duct	4 5-10 11	Rudimentary	11 and 12	In line <i>b</i> , on the medial side of strongly pronounced longitudinal pads	Unpaired ventral-medial papilla in furrow 19/20	13-15	Distinct	13-17	L 80 D 3	120	Brazil, Florida?, Jamaica?, Bermuda?
<i>ephippiger</i> ...	Deep yellow	Slightly epilobous	Behind the clitellum: $aa \approx 2ab$; $ab = bc = cd$ (almost); $ab < bc < cd$; $dd = 3cd$; <i>bc</i> greater anteriorly	<i>b</i> on small papillae	A slender ampulla-shaped diverticulum longer than the main pouch	9 10-12 13	Lacking	11 and 12	In line <i>b</i> , on the medial side of lateral swellings. A ventral-medial groove.	Unpaired ventral-medial papilla in furrow 19/20	...	Distinct	13-17 Saddle-shaped	L 43-47 D 3	85-100	Christmas Is., Hawaii, Celebes, California.
<i>ephippiger</i> ...	Light grey, or olive green with a reddish clitellum	Epilobous	Unornamented: $ab \approx aa$; $\frac{1}{3}bc \approx \frac{1}{3}cd$ Behind the clitellum: $ab \approx \frac{1}{2}aa$; $aa \approx bc \approx cd$; $dd \approx 2cd$	<i>b</i> on papillae	Duct nearly as long as the elongated ovoid sac. Tubular diverticulum with an independent opening to exterior.	5 6-12 13	Lacking	11 and 12	In line <i>b</i> on small papillae lying on the inner side of a groove medial to pronounced longitudinal walls	Variable. Most constant; papilla in 19/20. Often a papilla in 12/13, rarely in 13/14.	1 or a pair in 13 Lacking in 14	Distinct	$\frac{1}{2}$ 13-17 Saddle-shaped	L 32-65 D 2-21	106-108	India (Chilka Lake).
<i>ephippiger</i> ...	Creamy-white with a reddish tone	Slightly epilobous	Sometimes slightly ornamented: $ab < cd$	<i>b</i>	Diverticulum longer than main pouch, and opening individually to the exterior	5 6-12 13	Lacking	11 and 12	The longitudinal walls extend slightly towards the mid-ventral line along 17/18 and 18/19. A pair of small papillae between <i>a</i> and <i>b</i> .	Variable. Ventral-medial papilla in 19/20. A thickening of the anterior-ventral margin of 14 may occur.	13	Distinct	Lacking	L 85 D 2	97	Western Australia (Leighton and Costelloe).
<i>laccadivensis</i> ...	...	Slightly epilobous	...	<i>b</i> at each end of a dumb-bell shaped thickening	Sac-like, with a tubular diverticulum as long as the main pouch. A distinct duct.	6 7-12 13	Feeble, in seg. 7	11 and 12	As in <i>Pontodrilus matsushimensis</i>	Ventral-medial papilla in 19/20. Anterior papillae somewhat similar to those in <i>P. matsushimensis</i> var. <i>chathamiana</i> , but variable.	13	Distinct	13-17 Saddle-shaped	L 90-110	...	Maldives and Laccadive Is.
<i>matsushimensis</i> ...	White with a light red tone	Epilobous $\frac{1}{2}$	Short and simple: $ab < cd$...	<i>b</i>	With a diverticulum ...	5 6-12 13	Rudimentary	11 and 12	In a rectangular glandular field with swollen lateral margins overhanging the pores	Ventral-medial papilla in 19/20	13	Indistinct	12 or 13-17 Complete	L 90-110 D 3-34	100-105	Japan, New Caledonia, Isle of Lines.
<i>matsushimensis</i> var. <i>chathamiana</i> ...	...	Proilobous	...	...	Diverticulum truncate ...	...	...	...	...	Ventral-medial papillae in 11/12, 12/13, 14/15, 19/20. Ventral surface of segs. $\frac{1}{2}$ 7- $\frac{1}{2}$ 9 glandular.	...	Indistinct	Lacking (immature?)	D 31	...	Chatham Is.
<i>michaelsenii</i> ...	Faded flesh-colour	Epilobous $\frac{1}{2}$	Smooth: $cd > ab$ (slightly); $aa > bc$ (slightly); $aa = 2ab$	<i>b</i> at each end of a biscuit-like papilla	Cylindrical with an ampulla-shaped diverticulum 2.3 as long as the main pouch	4 5-12 13	Rudimentary	11 and 12	In line <i>b</i> between 2 pairs of papillae, 1 medial, 1 lateral to pores	...	13	Distinct	13-17 Saddle-shaped	L 83 D 3	...	Mexico.
<i>albanyensis</i> ...	Yellowish-grey	Epilobous $\frac{2}{3}$ (ca.)	Not distinctly ornamented: $aa = 2ab$; $ab \approx bc$; $\frac{1}{3}cd$; $cd = \frac{2}{3}dd$	<i>b</i>	Sac-like, the duct half as long as the main pouch, but not sharply defined. Diverticulum half as long as main pouch.	5 6-13 14	Rudimentary in seg. 5	11 and 12	In line <i>b</i> on small medially bending papillae	Two unpaired ventral medial papillae in 17/18 and 18/19. Small pair papillae between <i>a</i> and <i>b</i> in 18/19.	13 Lacking in 14	Distinct	Lacking	L 50 D 2	86	Western Australia (Albany).
<i>albanyensis</i> var. <i>cygni</i> ...	Colourless with a red tone	Slightly epilobous	Ornamented: $ab < cd$; <i>d</i> dorso-lateral	...	Elongated ovoid sac merging into duct. Cylindrical diverticulum half as long as the main pouch.	6 7-12 13	Rudimentary	11 and 12	In line <i>b</i> on papillae	Pair of small papillae between <i>a</i> and <i>b</i> in 18/19. Unpaired papillae in 17/18, 18/19, 19/20, 20/21.	13 Lacking in 14	Distinct	Lacking	L 140 D 3	90 (ca.)	Western Australia (Swan River).
<i>hesperidum</i> ...	...	...	Unornamented and wide-set	...	With a cylindrical diverticulum	5 6-12 13	Lacking	11 and 12	In place of the <i>b</i> setae	...	...	...	...	L 25 D 1	...	Jamaica.
<i>crosslandi</i> ...	...	Epilobous $\frac{1}{2}$ - $\frac{1}{3}$	$ab < cd$ ...	...	Diverticulum half as long as the main pouch	13 14	Not prominent	11 and 12	In line <i>b</i> , each opening to a depressed area divided by a transverse fold	Paired kidney-shaped papillae in line <i>a</i> at furrows 13/14 and 14/15	15	Distinct	13-18	L 100	...	Shores of the Red Sea.
<i>agnesae</i> ...	Dark brown	Proilobous almost zygolobous	$aa = 2ab$; $bc = 1\frac{1}{2}ab \approx cd$; $dd = 3cd$ (ca.) $\frac{1}{2}$ circumference; <i>a</i> and <i>b</i> missing from seg. 18	...	Sub-spherical with a stout duct not sharply defined. Diverticulum club-shaped half main pouch.	7 8-12 13	Lacking	9 and 12	Between <i>a</i> and <i>b</i> on small papillae	Lacking	13 (12?)	Indistinct	13-17 or 17 Ventrally in the form of a groove.	L 65 D 1	116	India, Ceylon.
<i>litoralis</i> ...	...	Epilobous $\frac{1}{2}$	Smooth and simple: $aa \approx bc$; cd ; $ab = \frac{1}{2}aa$; $dd \approx 2aa$	<i>a</i>	Pear-shaped, with a small pear-shaped diverticulum	...	Lacking	11 and 12	In line <i>a</i> ...	Unpaired ventral-medial papillae in 19/20 and 20/21	15	Distinct	13-17 Complete	L 100 D 4	...	Southern France



3. Genus MEGASCOLIDES McCoy.

Eight setae per segment. Spermathecal pores, 2-5 pairs, the last in furrow 8/9. 1 gizzard in segment 5 or 6, or in 5 and 6. Micronephridial in the anterior region of the body. Spermiducal glands tubular with a simple unbranched canal.

Australia, Tasmania, New Zealand (North Isl.), and west of North America.

Megascolides nokanenaensis, Michlsn.

Colour, a dirty yellow-gray with a trace of red-brown pigmentation encircling the head end. Setae: $aa = bc$, $ab < bc < cd < \frac{1}{2} dd$; $dd = \frac{1}{3} u$; Posteriorly ab becomes approximately equal to aa and the lines c and d become irregular. First dorsal pore in furrow 6/7. Clitellum covers segments $\frac{1}{4}13$ - $\frac{1}{2}18$ and is complete but not so well developed ventrally in segments 14-16. Male pores on tiny whitish papillae in the a line of setae in segment 18; 4 pairs of spermathecal pores also in line a in furrows 5/6-8/9. Accessory glands consist of one pair of indistinctly defined oval papillae in segment 17 between the lines a and b . Septa slightly thickened in the anterior male genital region. Gizzard in segment 6 (?); oesophagus with a folded vascular wall, without calciferous glands. Mid-gut without a typhlosole. Excretory system for the most part micronephridial; in the posterior segments the micronephridia blend to form one meganephridium on each side in each segment. 2 pairs of testes and funnels in segments 10 and 11; spermiducal glands tubular and thick-walled, with a narrow lumen; the glandular region is coiled, the loops being so closely pressed as to make the structure appear to be of the compact Pheretima type. Penial setae delicate and curved, the distal region irregularly bent; the extreme distal end is flattened and diverges into 2 slender, slightly curved teeth; distally, with the exception of this flattened region, each seta is beset with scattered scars which resemble small teeth lying flat against the seta. Spermathecae consist of a sac-like ampulla and a sharply defined duct which is almost as long as the ampulla; a simple pear-shaped diverticulum opens into the duct just above its distal end.

Length: 32 mms.; diameter 2 mms.; number of segments 84.

Locality: Northampton.

4. Genus WOODWARDIELLA, Stephenson.

Syn. *Woodwardiella* Stephenson. P.Z.S. 1925, p. 888.

Woodwardia Michlsn. 1907 Fauna S.W. Austr. I. p. 161. nec Crosse & Fisher 1861 (Mollusca)....

Eight setae per segment. 1 gizzard in segment 5 (or a neighbouring segment?). Always meganephridial. Spermiducal gland with a branching canal-system in the glandular region.

Australia, Tasmania, and Celon.

KEY TO SPECIES OF WOODWARDIELLA.

- | | |
|--|----------------------------|
| 1. { Male pore in the a line of setae—2. | |
| 1. { Male pore between the a and b lines of setae—3. | |
| 2. { Male pores in a depressed oval area | 5. <i>W. magna</i> . |
| 2. { Male pores on small papillae | 2. <i>W. affinis</i> . |
| 3. { Thickened ridges occur posterior to the male pore | 1. <i>W. callichaeta</i> |
| 3. { Thickened ridges do not occur posterior to the male pore—4. | |
| 4. { Penial setae with a simple distal tip | 4. <i>W. molacelonis</i> . |
| 4. { Penial setae with a flattened spade-like tip | 3. <i>W. tipferti</i> . |

1. *Woodwardiella callichaeta*, Michlsn.

Colour, a dirty gray, the head-end being clearer. Head epilobous. Setae wide apart: $aa = bc = \frac{1}{2}dd$, $ab = \frac{1}{3}aa$; $cd = \frac{4}{5}aa$; posteriorly

$cd = bc$ (approx.). Dorsal pores only known posterior to the clitellum. Clitellum complete, covering segments 14–17. Male pores on small oval papillae in segment 18, between the a and b lines of setae. Spermathecal pores, 2 pairs in the a line of setae in furrows 7/8 and 8/9. Accessory glands consist of narrow elongated pads in either of furrows 19/20 and 20/21, or in both; in one specimen these pads occurred in 11/12 and 19/20. Septa 9/10 and 10/11 slightly thickened, those immediately before and after gradually becoming more delicate. Gizzard large in segment 5; oesophagus with a vascular wall thrown into folds internally, without calciferous glands, but with a pair of short stout sacculations in segment 13 (?). Last heart in segment 12. 2 pairs of testes and funnels in segments 10 and 11; 2 pairs simple sperm sacs in segments 9 and 12, the posterior pair large, the anterior small. Spermiducal glands loosely racemose with a slightly curved duct equal in length to the glandular region. This duct is unusual in having a branching lumen, the branches proximally directed. Penial setae flattened distally ending in 2 small prongs which give the apical margin a concave curve; the distal portion is beset with slender, moderately long sloping teeth arranged in 3 fairly regular longitudinal rows. The spermathecae consist of a long ampulla divided into 2 regions; the proximal region is smooth thin-walled and sac-like, and filled with a granular mass; the distal region is neck-like and thicker walled, and merges into a short duct; a long cylindrical diverticulum opens into the distal end of the neck-like region.

Length: 50 mms.; diameter $2\frac{2}{3}$ mms.; number of segments about 140.

Locality: Jarrahdale.

2. *Woodwardiella affinis*, Michlsn.

Colour, dirty gray. Head tanylobous. Setae: $aa = 2ab = 1\frac{1}{2}bc$; $bc - cd$; $dd - \frac{1}{4}u$ anteriorly, but $-\frac{1}{6}u$ posteriorly. First dorsal pore in furrow 6/7 or further forward. Clitellum complete covering segments 14–17. Male pores on small papillae in segment 18 in the a line of setae; spermathecal pores, 2 pairs, in furrows 7/8 and 8/9 immediately lateral to the a line of setae. Accessory glands consist of oval glandular areas extending to the a line on each side in furrow 11/12 and in segments 19 and 20, the last 2 not so distinct and the last one slightly smaller. Septa 6/7 15/16 very slightly thickened. Gizzard in segment 5; oesophagus without calciferous glands but in the hinder region the wall is vascular and thrown into longitudinal folds internally, and in segment 16 there is a large dilatation. Last heart in segment 12; 2 pairs of testes and seminal funnels in segments 10 and 11; 2 pairs of large irregular sperm sacs in segments 9 and 12; free seminal masses in segments 10 and 11. Spermiducal glands short, broad and deeply-lobed, with a distinct irregularly bent duct. Penial setae curved, the curve being more acute distally; the extreme distal end is flattened at right-angles to the plane of the curve or terminates in a flat plate which widens distally, the distal margin being concave; this flattened plate is bent back to form an angle with the convex side of the seta; the distal region of the seta, with the exception of this plate, is beset with large scattered teeth. Spermathecae elongated and sac-like, merging into a narrow duct; an ampulla-shaped diverticulum opens into the narrow distal region of the ampulla.

Length: 22–32 mms.; diameter 1–1 $\frac{1}{2}$ mms.; number of segments, 85–103.

Locality: Jarrahdale.

3. *Woodwardiella lipferti*, Michlsn.

Colour, gray with a yellowish clitellum. Setae: $aa = 2ab = bc$
 $\frac{1}{2} cd$; $dd = aa < \frac{1}{2} u$. First dorsal pore in furrow 5/6. Clitellum complete, covering segments 14–17. Male pores on oval papillae in segment 18, between the a and b lines of setae. Spermathecal pores, 2 pairs, in furrows 7/8 and 8/9, just above line a . Accessory glands represented by a single elongated ventral-median pad extending beyond the a line of setae on each side in furrow 11/12. Septa in the region of the testes slightly thickened. Gizzard large; calciferous glands lacking. Spermiducal glands flattened, racemose, and closely pressed against the body-wall, with a short narrow duct. Penial setae simple and tapering, but curved distally. The extreme distal end is flattened, widened, and spade-like with a concave distal margin; the convex side of the distal region, with the exception of the flattened portion, is marked by annular ribs, each bearing a row of small teeth. Spermathecae irregular and sac-like, sometimes with definite sacculations merging into a thick-walled duct; a sausage-shaped diverticulum opens into the duct about half-way down its length.

Length: 40 mms.; diameter $1\frac{2}{3}$ mms.; number of segments, 106.

Locality: Subiaco.

4. *Woodwardiella MOLAELEONIS*, Michlsn.

Colour, yellow to gray, owing to the colour of the gut-contents. Head epilobous. Setae: $aa > bc > dd > cd > ab$. First dorsal pore in furrow 6/7 (further forward?) Clitellum complete, covering segments 14–17. Male pores on oval papillae in segment 18 between the a and b lines of setae. Spermathecal pores, 2 pairs, in furrows 7/8 and 8/9, just lateral to line a . Accessory glands represented by a single elongated pad extending nearly to line b on each side in furrow 10/11. Septa in the region of the male organs slightly thickened. Gizzard relatively large (in segment 5 or 6?); the hinder part of the oesophagus with a slightly folded inner surface; Calciferous glands do not appear to occur. Last heart in segments 12. Meganephridia occur in the middle and hinder regions of the body, from segment 24 at least; further forward they are apparently divided into a few irregular micronephridia, though this condition may be due to a breaking up during fixation. Testes and funnels, 2 pairs in segments 10 and 11; sperm sacs, 2 pairs in segments 9 and 12, the former simple the latter lobed though one lobe is always larger than the others. Spermiducal glands round the racemose, but closely pressed and flattened, with a short duct. Penial setae delicate, the distal end bent and tapering; below the smooth tip each seta beset with teeth arranged in whorls of 2, 3, or 4. Spermathecae long and sac-like with a distinct duct about half as long as the ampulla; a slender club-shaped diverticulum opens into the distal end of the ampulla.

Length, 20 mms.; diameter, $1\frac{1}{3}$ mms.; number of segments 84 or 89.

Locality: Lion Mill.

5. *Woodwardiella magna*, Sp. nov.

Pl. XV., Figs. 7, 10. Text-fig. 9.

External features: Length, 80 mms. in life; diameter, 2–3 mms.; number of segments 111.

The worm is colourless and at first glance appears to be devoid of external markings.

The head is tanylobous with a large and distinct prestomium.

The first dorsal pore occurs in furrow $3/4$ in one specimen, and $5/6$ in the other.

The clitellum is distinct and covers segments 14–18, though the intersegmental furrows are also clearly visible in this region, and in segment 18 the glandular thickening is apparently only lateral. The ventral region of these furrows is more deeply marked between segments 13 and 14, and again between 17 and 18.

The male pores are in segment 18 and lie in a depressed oval area. They are in the α line of setae and open immediately behind the conspicuous orifices of the penial setae.

There are two pairs of spermathecal pores lying in furrows $7/8$ and $8/9$ in the α line of setae on each side.

The accessory glands consist of an elongated oval slightly-raised area extending across the ventral surface of furrows $11/12$ as far as the α line of setae on each side. One specimen was marked by a similar but smaller area on segment 19, while on the other there seemed to be a slight indication of a glandular area in furrow $22/23$. None of the markings, with the exception of the oval area on segment 18 is at all distinct.

Anatomy : Septa $7/8$ – $11/12$ show a slight thickening, $8/9$ and $9/10$ being the strongest.

The gizzard is large and well-developed and lies in segment 5. The oesophagus has no lateral calciferous glands, but it is swollen in each segment and has a good blood supply. The mid-gut begins in segment 18.

The last heart lies in segment 12.

The excretory system is meganephric.

The male genital system consists of two pairs of sperm sacs projecting into segments 9 and 12, and two pairs of seminal funnels in segments 10 and 11. In one specimen only the sperm sacs of segment 12 were present. The testes were not seen, but free sperm masses filled the segments containing the funnels. The spermiducal glands are large and oval with an irregular margin, and a surface broken into numerous small areas which suggest lobes flattened and pressed together. The slender muscular duct opens approximately into the centre of the ventral surface of the glandular region.

The penial setae are curved and slender, tapering gradually from the stouter base. Apically they flatten in a plane at right angles to that of the curve, and end in a small fork. Of the five setae examined one was as described above, two were broken, the third was damaged and bent at the distal end and no fork was observed, and the last showed a forked tip that was slightly curved, there being a suggestion of a notch immediately behind the fork. They measure $\cdot 75$ – $\cdot 85$ mm. in length and with the exception of the flattened portion are marked distally by annulations bearing fine but irregular teeth.

The ovaries and oviducal funnels are normal in position. The external openings of the oviducts were not seen, but probably they lie far forward in segment 14, in the intersegmental groove of the clitellum mentioned above.

The spermathecae are large, irregular, and somewhat elongated, with a diverticulum which varies considerably in length opening into the proximal end of the duct.

Locality : Lesmurdie.

Remarks : Only two specimens were obtained but both of these were much larger than any of those of the same genus recorded by Michaelsen. They appear to come remarkably close to his *Woodwardia affinis*, differing chiefly in size, colour, and the condition of the area surrounding the male pores. Even the penial setae show a close resemblance, though they lack the tiny apical curve.

5. Genus NOTOSCOLEX Fletcher.

Eight setae per segment. Spermathecal pores 2 or 3 pairs, the last in furrow 8/9. 1 gizzard in segment 5 or 6. Micronephridial at least in the anterior region of the body. Spermiducal glands with a branching lumen.

Australia, Tasmania, and Ceylon.

KEY TO SPECIES OF NOTOSCOLEX.

- | | | |
|----|--|-----------------------------|
| 1. | { Male pores in the <i>b</i> line of setae—2. | |
| | { Male pores medial to the <i>b</i> line of setae—3. | |
| 2. | { 1 pair of sperm sacs | 1. <i>N. maecenatis</i> . |
| | { 2 pairs of sperm sacs | 3. <i>N. prestonianus</i> . |
| | { 3 pairs of sperm sacs | 7. <i>N. leios</i> . |
| 3. | { Male pores medial to the <i>a</i> line of setae | 6. <i>N. suctorius</i> . |
| | { Male pores lateral to the <i>a</i> line of setae—4. | |
| 4. | { Spermathecal pores in the <i>b</i> line of setae | 5. <i>N. rubescens</i> . |
| | { Spermathecal pores medial to the <i>b</i> line of setae—5. | |
| 5. | { Penial setae with a forked distal tip | 2. <i>N. hortensis</i> . |
| | { Penial setae with a simple distal tip | 4. <i>N. modestus</i> . |

1. *Notoscolex maecenatis*, Michlsn.

Flesh coloured or brownish-red anteriorly ; the hinder part of the body white or gray owing to the colour of the gut-contents. Epilobous : segment 1 with a longitudinal dorsal-median furrow. Setae : $aa = 2 ab$, $ab = \frac{1}{2} bc$, $bc = \frac{1}{2} cd$, $dd = \frac{9}{5} cd > \frac{1}{4} u$; setae *c* and *d* irregularly set in the last 20 segments. First dorsal pore in furrow 3/4. Clitellum saddle-shaped covering segments 14–17. Male pores on small oval papillae in the *b* line of setae in segment 18. Spermathecal pores, 2 pairs in furrow 7/8 and 8/9 in line *b*. The ventral surface of segments 10–19 is depressed, the depression extending to the *a* line of setae on each side and being bounded anteriorly by glandular thickenings in segments 8 and 9, and posteriorly by an elongated glandular ridge in furrow 19/20. Septa 6/7–12/13 thickened. Gizzard in segment 6 ; oesophagus swollen in segments 9–13, the wall being vascular and thrown into folds internally ; no calciferous glands ; mid-gut begins in segment 16. Last heart in segment 12. Meganephridia occur in about the last 20 segments. Testes and seminal funnels, 1 pair in segment 10 ; free seminal masses in segment 11 ; 1 pair of racemose sperm sacs in segment 12. Spermiducal glands flattened, rectangular, and loosely racemose, with a slightly bent duct. Penial setae simple with a sharp terminal bend ; distally the axis bends at right angles and widens to a delicate, slightly hollowed disc ; the distal end with the exception of the bent tip is marked by toothed annulations. Spermathecae with a flat sac-like ampulla the wall of which is apparently thrown into annular folds internally, these rings becoming irregular at the base ; the club-shaped diverticulum opens either into the base of the ampulla or the proximal end of the conical (or cylindrical) duct.

Length, 50–52 mms. ; diameter, 3 mms. ; number of segments, 120.

Locality : York.

2. *Notoscolex hortensis*, Michlsn.

Head epilobous ; segment 1 with a broad longitudinal mid-dorsal furrow which is separated from the true prestomium by a transverse furrow. Setae : $aa = cd > bc > ab$; at the hinder end $ab > aa$; $dd = \frac{1}{3} - \frac{1}{8} u$. First dorsal pore in furrow 4/5. Clitellum complete but less strongly developed ventrally, covering segments $\frac{1}{3}$ 13 or 14–17. Male pores on small oval papillae in segment 18 between the *a* and *b* lines of setae. Spermathecal pores, 2 pairs in furrows 7/8 and 8/9 immediately lateral to the *a* line of setae. Glandular thickenings occur on the ventral part of segments 8 and 9, sometimes with tiny ventral-median papillae in furrows 7/8 and 8/9 ; usually 1 pair of large flat papillae in line *a* in furrow 19/20. Septa 9/10–11/12 slightly

thickened. Gizzard in segment 6 ; oesophagus with internal structure resembling that of a calciferous gland but definite glands do not occur ; mid-gut begins in segment 15 and has a broad typhlosole. Last heart in segment 12. The nephridia of the last segment unite to form one pair of meganephridia. 2 pairs of testes and seminal funnels embedded in ripening sperm masses in segments 10 and 11 ; 2 pairs of large simple sperm sacs in segments 9 and 12. Spermiducal glands nearly as long as wide, consisting of closely pressed lobes, and with a delicate slightly curved duct. Penial setae delicate and tapering, the distal tip slightly flattened and forked, the two prongs of the fork sometimes bound together by a web ; with the exception of this tip the distal region is marked by broad scattered teeth closely pressed against the seta giving it a nodular appearance. Spermathecae narrow and irregular, tapering distally to a short bent duct ; a club-shaped diverticulum containing a single sperm chamber opens into the distal end of the ampulla.

Length, 35–45 mms. ; diameter, 2–2½ mms. ; number of segments, 106–120

Locality : Dongarra, Lion Mill, Jarrahdale, Gooseberry Hill.

3. *Notoscolex prestonianus*, Michlsn.

Colour, dirty gray. Head epilobous ; segment 1 with a longitudinal mid-dorsal furrow, and only faintly marked off from segment 2. Setae : $aa = 2ab$, $ab = \frac{2}{3} bc = cd$, $dd = \frac{1}{4} u$; at the hinder end : $aa = \frac{3}{2} ab = \frac{1}{5} bc$, $cd = \frac{2}{3} bc$, $dd = \frac{1}{2} cd$, and here seta d is twice as long and broad as seta a ; at the extreme distal end the dorsal setae are irregular in position. First dorsal pore in furrow 4/5 (3/4?). Clitellum complete but faintly developed ventrally and entirely lacking in the ventral part of the anterior and posterior segments ; it covers segments 13–17. Male pores on small oval papillae in the b line of setae in segment 18 ; spermathecal pores, 2 pairs in furrows 7/8 and 8/9 slightly lateral to line b . Accessory glands represented by 4 pairs of small oval papillae in furrows 15/16, 16/17, 19/20 and 20/21, slightly medial to the position of male pores, in line b or between a and b . Septa thickened in the region of the testes. Gizzard in segment 6 (?) ; oesophagus without calciferous glands. 2 pairs of testes and seminal funnels in segments 10 and 11 ; 2 pairs of sperm sacs, those in segment 9 small and simple, those in segment 12 large and racemose. Spermiducal glands broken into lobes ; duct short and distinct. 2 types of penial setae occur ; a slender form with a simple distal tip, the distal end beset with tiny scars each bearing a delicate tooth in its proximally directed cavity ; and a stouter form, simply curved, the distal tip (in one case) flattened and spatulate, and the distal region beset with large scattered teeth closely pressed against the shaft of the seta. Spermatheca with a pear-shaped ampulla swollen basally and merging into a short narrow duct ; a short simple diverticulum opens into the distal end of the ampulla.

Length : 30 mms. ; diameter, 2–2½ mms. ; number of segments, about 95.

Locality : Donnybrook.

4. *Notoscolex modestus*, Michlsn.

Colour, gray. Head epilobous ; segment 1 with a mid-dorsal furrow. Setae anteriorly $aa = 2ab = 1\frac{1}{2} bc = cd$, $dd < \frac{1}{3} u$; posteriorly $aa = \frac{3}{2} ab = bc = cd = dd$. Clitellum complete, covering segments 14–17. Male pores in segment 18 on papillae between the a and b lines of setae, the papillae being connected by a ventral-median glandular field. Spermathecal pores 2 pairs in furrows 7/8 and 8/9 immediately lateral to the a line of setae. Unpaired mid-ventral glandular pads extending to line a on each side occur

in furrows 16/17, 18/19, 19/20 and 20/21, also, but less distinctly in 7/8, 8/9, 9/10, and 17/18; in each case the intersegmental furrow is clearly visible; these markings may be entirely lacking, or only the posterior 4 may occur. Septa 9/10 and 10/11 slightly thickened. Gizzard in segment 6 (segment 5?); oesophagus without califerous glands. Last heart in segment 12. Micronephridia occur in the anterior and middle regions of the body. Seminal funnels, 2 pairs, in segments 10 and 11; 2 pairs of large sac-like sperm sacs in segments 9 and 12. Spermiducal glands closely pressed against the body wall of segments 17-19, loosely racemose, with a short duct. Penial setae curved and tapering, the curve being sharper at the distal end; typical ornamentation not definitely known but the distal end is apparently marked by long flat scars, and one seta had a small tooth just below the distal tip. Spermathecae elongated and sac-like ending proximally in a wart-like point, and merging distally into a short narrow duct; a pear-shaped diverticulum opens into the distal end of the ampulla.

Length, 30-40 mms.; diameter, $1\frac{1}{2}$ - $2\frac{1}{2}$ mms.; number of segments, 100-110.

Locality: Yarloop and York.

5. *Notoscolex rubescens*, Michlsn.

Colour, dirty gray, due to the colour of the gut contents; the head end faintly pink. Head epilobous; peristomium with a mid-dorsal longitudinal groove. Setae: $aa = \frac{3}{2} ab = bc < cd$; $dd = \frac{1}{4} u$; setae c and d irregularly placed in about the last 40 segments. First dorsal pore in furrow 5/6 (if not in 4/5 or 3/4). Clitellum saddle-shaped, covering segments 14/17. Male pores in segment 18 slightly lateral to the a line of setae on distinct papillae the bases of which extend from the a to b line of setae on each side. Spermathecae, 2 pairs of transverse slits in the b line of setae in furrows 7/8 and 8/9. Accessory glands consist of elongated glandular streaks or ridges close before and behind each of furrows 15/16-19/20. Septa 6/7-12/13 somewhat thickened. Gizzard in segment 6 (5?); oesophagus without calciferous glands; mid-gut without a typhlosome at least as far as segment 30. Micronephridia occur in the anterior and middle regions of the body—the posterior end is not known, 2 pairs of seminal funnels in segments 10 and 11; 1 pair of compressed racemose sperm sacs in segment 12 (a second pair in 9?). Spermiducal glands also racemose lying against the lateral and dorsal walls in the region of segments 17-20; duct short, narrow and s-shaped, and hidden beneath the glandular region. Penial setae faintly curved, the curve being sharp distally, the extreme tip slightly bent in the opposite direction, the convex side of the distal end, with the exception of the recurved tip, is beset with transverse rows of small thorns. Spermathecae with a thick pear-shaped or spherical ampulla about twice as long as the stout duct; a small egg-shaped unstalked diverticulum opens at the junction of ampulla and duct.

Length, 35 mms.; diameter, $2-2\frac{1}{3}$ mms.; number of segments, 102.

Locality: Pickering Brook.

6. *Notoscolex (Trinephrus) sutorius*, Michlsn.

Colour, yellow; Head, epilobous; segment 1 with a longitudinal mid-dorsal furrow. Setae: $aa = 1\frac{2}{3} ab$, $ab = \frac{2}{3} bc$, $bc = \frac{3}{4} cd$, $dd = \frac{4}{9} u$. First dorsal pore in furrow 4/5. Clitellum saddle-shaped, covering segments 13-18. Male pores in segment 18 medial to the a line of setae, in a depressed glandular oval area with raised margins. Sper-

mathecal pores, 2 pairs in furrows 7/8 and 8/9, medial to line *a*. Accessory glands consist of 2 pairs of large oval sucker-like papillae in furrows 15/16 and 16/17, their centra lying just above the *b* line of setae; the whole of the ventral surface of segments 15-17 is glandular. Septa 9/10-11/12 slightly thickened. Gizzard in segment 6; oesophagus without calciferous glands, the internal wall thrown into slight folds; mid-gut begins in segment 14 or 15. Last heart in segment 12. 3 micronephridia occur on each side of the body in each segment; these unite in the last segments and appear to form one meganephridium on each side. 2 pairs of testes and seminal funnels and also free masses of ripening sperm matter in segments 10 and 11; 1 pair of lobed sperm sacs in segment 12. Spermiducal glands tongue-like with a notched margin and a broken surface; duct shorter than the glandular region. Penial setae lacking. Spermathecae with a club-shaped ampulla merging into a short narrow duct; a slender diverticulum opens at the junction of ampulla and duct.

Length: 35-55 mms.; diameter, 2-3 mms.; number of segments, 114-124.

Locality: Bridgetown.

7. *Notoscolex leios*, Sp. nov.

Pl. XV., Figs. 3, 5.

External features: Length, 95 mms.; width, 3 mms.; number of segments, 170.

The worm is of a smooth gray colour and unpigmented.

Head epilobate, the prestomium being cut off from the peristomium by a straight, transversely-running groove.

The setae are almost indistinguishable, and the entire body is marked by numerous fine annulations which give it a very smooth appearance.

The first dorsal pore lies between segments 4 and 5.

There was, in the specimen obtained, no clitellum and no accessory gland, and the spermathecal and genital pores were too small to be seen even with the aid of a lens.

Anatomy: Septa 6/7 - 13/14 are thickened, though very faintly in the case of 6/7.

Gut: There is a strong well-formed gizzard in segment 6. The oesophagus has no calciferous glands, but it is thick-walled and strong with a rich blood supply in segments 12 and 13, and again in segments 15 and 16. The mid-gut begins in segment 18.

The last heart is in segment 13.

The nephridial system is micronephric, the nephridia being arranged in lines encircling the body in each segment, though the number per segment does not seem to be constant. They are smaller in the anterior end of the body than in the posterior end and in segments 5-7 are numerous and closely packed.

There are three pairs of incompletely developed sperm sacs in segments 10, 11 and 12 and in segments 10 and 11 small whitish patches were seen on the posterior septa which were possibly the developing sperm-duct-funnels. The spermiducal glands in segment 18 are cylindrical with a nodular surface, and open to the exterior apparently in the *b* line of setae, through a muscular duct which is about one-third as long as the glandular region.

Penial setae are present. They lie in elongated sacs immediately anterior to and nearly as long as the spermiducal glands, which therefore, at first glance appear to be double. The setae themselves are about .75 mm. long, slender and curved with a very finely, but not very closely toothed concave surface and with one tiny isolated tooth near the end of the convex surface.

The spermathecae are very small, probably not fully developed, with a sac-like body into the base of which opens a long slender cylindrical diverticulum. There are two pairs of spermathecae opening between segments 7-8 and 8-9.

Locality : Murchison.

Remarks : Only one specimen of this worm was found, and the condition of the genital system indicates that it is immature. The absence of clitellum and accessory glands is, therefore, probably due to incomplete development and is not a constant feature of the species.

6. GENUS MEGASCOLEX. Templet.

More than 8 setae per segment at least in the middle and hinder region of the body. Spermathecal pores, 2-5 pairs between segments 4-9. 1 gizzard in segment 5, 6, or 7. Micronephridial. Spermiducal gland with a branching lumen.

Australia, Norfolk Is., Ceylon, and India (?).

KEY TO SPECIES OF MEGASCOLEX.

- | | | | | | | | | | |
|--|--|--|--|--|--|--|--|-----|-------------------------|
| 1. { Spermathecal pores unpaired—2. | | | | | | | | | |
| 1. { Spermathecal pores paired—3. | | | | | | | | | |
| 2. { 2 Spermathecal pores | | | | | | | | 14. | <i>M. syndetoporus.</i> |
| 2. { 3 spermathecal pores | | | | | | | | 2. | <i>M. harveyensis.</i> |
| 2. { 5 spermathecal pores | | | | | | | | 1. | <i>M. imparicystis.</i> |
| 3. { Spermathecal pores medial to the <i>a</i> line of setae—4. | | | | | | | | | |
| 3. { Spermathecal pores in or lateral to the <i>a</i> line of setae—5. | | | | | | | | | |
| 4. { Spermathecae with glandular structures near the base | | | | | | | | 3. | <i>M. whistleri.</i> |
| 4. { Spermathecae devoid of glandular structures | | | | | | | | 13. | <i>M. swarbricki.</i> |
| 5. { Male pores medial to the <i>a</i> line of setae—6. | | | | | | | | | |
| 5. { Male pores lateral to the <i>a</i> line of setae—7. | | | | | | | | | |
| 6. { Spermathecal pores in the <i>a</i> line of setae | | | | | | | | 4. | <i>M. purpurascens.</i> |
| 6. { Spermathecal pores in the <i>d</i> line of setae | | | | | | | | 5. | <i>M. bistichus.</i> |
| 7. { Male pores between the <i>a</i> and <i>b</i> lines of setae—8. | | | | | | | | | |
| 7. { Male pores in or lateral to the <i>b</i> line of setae—10. | | | | | | | | | |
| 8. { Accessory glands occur—9. | | | | | | | | | |
| 8. { Accessory glands do not occur | | | | | | | | 15. | <i>M. albidus.</i> |
| 9. { Accessory glands paired | | | | | | | | 7. | <i>M. torbayensis.</i> |
| 9. { Accessory glands median and unpaired | | | | | | | | 6. | <i>M. monostichus.</i> |
| 10. { Accessory glands occur—11. | | | | | | | | | |
| 10. { Accessory glands do not occur | | | | | | | | 12. | <i>M. longicystis.</i> |
| 11. { Accessory glands in the form of rounded papillae—12. | | | | | | | | | |
| 11. { Accessory glands in the form of transversely elongated pads | | | | | | | | 10. | <i>M. galei.</i> |
| 12. { Spermathecal pores in the <i>b</i> line of setae | | | | | | | | 8. | <i>M. collicensis.</i> |
| 12. { Spermathecal pores in the <i>c</i> line of setae | | | | | | | | 9. | <i>M. albanyensis.</i> |
| 12. { Spermathecal pores in the <i>e</i> line of setae | | | | | | | | 11. | <i>M. collinus.</i> |

1. *Megascolex imparicystis*, Michlson.

Colour, dorsally dark violet, the head end gray, and ventrally a yellow or brownish gray. Head epilobous, segment 1 with a mid-dorsal longitudinal furrow; or tanylobous, the dorsal projection of the prestomium bearing a transverse furrow. Setae: *aa* = 1 $\frac{2}{3}$ *ab*; setal ring with an irregular mid-dorsal break. Dorsal pores occur. Male pores very close together in segment 18 in an eye-like genital area. Spermathecal pores, 5, unpaired and mid-ventral in furrows 4/5-8/9. Accessory glands represented by 7 elongated unpaired mid-ventral pads in furrows 14/15-16/17 and 19/20-22/23;

the intersegmental furrow is visible along each pad. Septa 7/8-17/18 thickened. Gizzard in segment 6 ; calciferous glands lacking oesophagus swollen in segments 10-14 ; mid-gut begins in segment 18. 2 pairs of closely pressed racemose sperm sacs in segments 11 and 12 ; 2 pairs of seminal funnels in segments 10 and 11. Spermiducal gland leaf-like with a slightly bent muscular duct which is $\frac{2}{3}$ the length of the glandular region. Spermathecae with a sac-like ampulla and a short narrow duct ; a small club-shaped diverticulum opens about half-way down the duct.

Length, 175 mms. ; diameter, 10 mms. ; number of segments, 168.

Locality : South-west Australia.

Remarks : 1907 *Megascolex imparicystis*. Sp. nov. Michaelsen : Die Fauna Sudwest-Australiens.

1926 *Megascolex affinis** Sp. nov. Nicholls and Jackson : Jour. Roy. Soc. Western Australia. Vol. XII., p. 145.

This species was described by Michaelsen in 1907 from one specimen the length of which was 175 mms. Last year a slightly smaller worm (140 mms.) was found, which, on account of several slight differences, was referred to a new species under the name *Megascolex affinis*. Recently a third specimen has been obtained from a garden in Mt. Lawley, and this, except for its exceptional size (450 mms.) has no features which justify its exclusion from the species *imparicystis*. The investigation of this third specimen has also led to the conclusion that the features on which the description of *M. affinis* was based were abnormalities and that its relations to the other two specimens are too marked to justify its separation into a new species. That all three belong to the same species seems the more likely, since a further knowledge of West Australian oligochaetes has shown that a great deal of variation occurs even among individuals of the same species.

The specimen described as *Megascolex affinis* differed from Michaelsen's type specimen chiefly in the slightly greater length of the diverticulum of the spermatheca and in the presence of a rudimentary third pair of sperm sacs in segment 13, but since only one specimen was collected it is impossible to be certain of the constancy of these two features. A third difference lay in the fact that in the type specimen elongated swellings occurred on the ventral surface in furrows 14/15, 19/20, 22/23, while the so-called *M. affinis* was devoid of accessory glands except for a very slight, probably glandular thickening of the ventral-median region of furrows 17/18 and 18/19. These two small swellings are, however, present in the specimen from Mt. Lawley in which the markings of the type specimen also occur with the exception of the swelling in 14/15, the only difference being that the swollen areas are all of equal size and not longer as they approach segment 18, as in the type specimen.

There is another point of resemblance between the so-called *M. affinis* and the giant specimen. The sperm sacs of the latter were found to contain dark-brown, hardened spherical patches which could easily be squeezed out from the surrounding tissue and which, when teased out and viewed under the microscope, were found to contain numerous sigmoid setae embedded in a dark granulated matrix. This matrix appeared to be quite structureless and suggested hardened secretion or a mass of disintegrating cells. A renewed examination of *M. affinis* revealed one small brown patch

* Dr. Gates has drawn attention to the fact that the name "affinis" was used by Perrier in 1872 for a species of *Perichaeta* which was later considered by Beddard to be a *Megascolex*, and suggests that though it is now ranked as a synonym for *Pheretima posthumus* this previous use of the term "affinis" would probably invalidate it for use to-day, even were the worm under discussion not now classed with *M. imparicystis*.

on one of the sperm sacs, the patch being found on removal to be identical with those of the larger specimen though it was smaller and contained but one seta. The significance of these bodies is unknown, for though they occur in the Lumbricidae they are always found in the body-cavity.

The above facts, together with the fact that neither testes nor ovary were observed in the earlier specimen, suggest that the so-called *M. affinis* is only an immature specimen of the same species as that of the giant earth-worm from Mt. Lawley, and there seems to be little doubt, except for the difference in size, that the species is the *Megascolex imparicystis* of Michaelsen. It will in any case be convenient to class all three together until further specimens have been obtained.

For future identification a description of the species based upon the study of the giant form is appended below. It will be noted that it varies from Michaelsen's description of the type specimen only in minor points; the length of the duct of the spermiducal gland; the extent of the thickened septa; and the pigmentation of the gut. This last was not mentioned by Michaelsen but probably it would not be noticeable in a specimen which had stood for some time in spirit. In view of the marked similarities the dark patches containing setae are of doubtful specific value.

External features: Length, 45 cms.; diameter, 10 mms.; number of segments, 176.

The worm is purplish-brown, dorsally, with a fine dark mid-dorsal line running from end to end. Laterally the colour fades to the creamy flesh tint of the ventral surface. In the pre-clitellar region the purplish tint is fainter. The clitellum itself is slightly browner than the rest of the body and, apart from the colouration, is noticeable only as a very slight constriction of segments 12 or 13-19. Each of these segments is marked by an annulus immediately anterior to the setal ring.

The head is tanylobous, the anterior margin of the peristomium being wrinkled. The walls of the buccal cavity are capable of eversion, the worm using its mouth in a sucker-like fashion. These walls when withdrawn are thrown into folds, against which the smooth firm rather triangular dorsal region of the prestomium gives a pro-epilobous appearance to the head.

The dorsal pores are conspicuous and occur from furrow 5/6 onwards. During fixation a considerable quantity of coelomic fluid was extruded through these pores, the fluid being of a pale yellow colour, and containing corpuscles roughly circular in shape.

The setae are small and inconspicuous.

The external indication of the male pore is very slight, but apparently the orifice is paired, the two pores being very closely approximated on an indistinct papilla on segment 18.

The female pores are also barely visible, but appear to lie in the annulus of segment 14, the annulus being somewhat deepened in the mid-ventral region.

There are five mid-ventral unpaired spermathecal pores lying in furrows 4/5-8/9.

Anatomy: The septa in both the anterior and posterior regions are muscular and thickened. Anteriorly the thickening begins with septum 8/9, septa 10/11-14/15 being extremely strong, 15/16 slightly less so.

The gizzard, which is large and well-formed, lies in segment 6, though it extends over the length of three segments. The crop preceding the

gizzard is light brown in colour, this brown pigmentation occurring again as a deep brown band in each segment of the oesophagus, and being continuous for the whole length of the intestine, that is from segment 17 onwards. It is probably due to the presence of chloragogen cells, though no histological examination was made. There are no lateral califerous glands.

The last heart lies in segment 13.

The excretory system, as normally in *Megascolex* is micronephridial. The nephridia are disposed in the same plane in each segment. Anteriorly they are ventoral in position and somewhat tufted in appearance, but posterior to the clitellum they become larger and encircle the body.

There are two pairs of racemose sperm sacs projecting from septa 10/11 and 11/12 into segments 11 and 12. They are small and apparently not fully developed, but they contain black spherical patches which can be squeezed out intact and which, when teased and examined under the microscope, are seen to have numerous sigmoid setae embedded in the dark matrix.

There are two pairs of testes and their related funnels in segments 10 and 11. The funnels are quite distinct, but the testes are extremely small. The spermiducal glands are large, flattened, and leaf-like, with a slightly curved muscular duct, the length of which is roughly one-third that of the glandular region.

The ovaries, which project from septum 12/13 into segment 13, are tufted and fairly conspicuous.

The spermathecae are median and unpaired, each with a small diverticulum opening into the distal end of the duct. The main pouch varies somewhat in shape, the first being elongated and finger-like, the others irregular and sac-like. The last is probably abnormal in that it has no diverticulum.

Locality: Mount Lawley.

2. *Megascolex harveyensis*. Michlsn.

Colour, dorsally dark violet-brown, ventrally gray. Head pro-epilobous (?). Setae: $aa = 2ab$; the mid-dorsal break in the setal ring is irregular. First dorsal pore in furrow 5/6. Clitellum not known. Male pores in segment 18, very close together, in a mid-ventral trapezoidal depression with raised margins. Spermathecal pores, 3, unpaired and mid-ventral in furrows 6/7, 7/8, and 8/9. One pair of small papillae in the b line of setae in furrow 20/21. Septa of the testes-segments slightly thickened. Gizzard in segment 6 (?). No calciferous glands. 2 pairs of seminal funnels in segments 10 and 11; 2 pairs of slender sperm sacs in segments 11 and 12; spermiducal glands leaf-like with a very short narrow duct. Spermathecae with a pear-shaped ampulla and a short duct; a club-shaped diverticulum opens into the proximal end of the duct. Length, 78–84 mms.; diameter, 5–5½ mms.; number of segments, 153–162.

Locality: Harvey.

3. *Megascolex whistleri*, Michlsn.

Colour, gray, the head end slightly reddish; the gut-contents, nephridia, and spermiducal glands can be seen through the skin. Head epilobous with a mid-dorsal longitudinal groove in segment 1 (tanylobous with a transverse furrow on the dorsal extension of the prestomium?) Setal rings with a regular mid-dorsal and mid-ventral break: $aa = 3ab$, $zz = 2yz$. First dorsal pore in furrow 4/5. Clitellum saddle-shaped covering segments 13–18. Male pores

in segment 18, very close to each other and opening through a mid-ventral transverse slit in an oval glandular area. Spermathecal pores, 2 pairs, close together and very near the mid-ventral line just behind furrows 7/8 and 8/9. Accessory glands consist of 2 small mid-ventral papillae in furrows 17/18 and 18/19, and 2 pairs of slightly larger papillae on the anterior margin of segments 19 and 20, those in 19 slightly farther apart; usually 1 or more of the papillae are lacking. 2 or 2 pairs of tiny gland pores also occur close against the spermathecal pores. Septa 8/9-11/12 faintly thickened. Gizzard in segment 6; oesophagus without calciferous glands but vascular and the wall slightly folded internally. Last heart in segment 13. In the middle region of the body 3 micronephridia occur on each side in each segment uniting at the hinder end so as to appear to form a pair of meganephridia. 2 pairs of testes and seminal funnels in segments 10 and 11; 3 pairs of sperm sacs in segments 11, 12 and 13. Spermiducal glands flat and pressed against the body-wall, slightly longer than wide, with a duct $\frac{1}{3}$ as long as the glandular region. Spermathecae with an elongated ampulla half as long again as the duct; a sausage-shaped diverticulum opens about half-way down the duct. Glands associated with the gland-pores mentioned above project into the body-cavity in the neighbourhood of the spermathecae.

Length, 38-45 mms.; diameter, $2\frac{1}{2}$ -3 mms.; number of segments, 120-124.

Locality: Boyanup.

4. *Megascolex purpurascens*, Michlsn.

Colour brownish, slightly purple anteriorly, and yellowish-gray ventrally. Head tanylobous. Setal rings with a regular mid-dorsal and mid-ventral break: $aa = 3ab$, $zz = 2\frac{1}{3}aa$. First dorsal pore in furrow 5/6. Clitellum saddle-shaped covering segments 13-18. Male pores in segment 18 slightly medial to the a line of setae, on an oval mid-ventral papilla. Spermathecal pores 2 pairs in the a line of setae in furrows 7/8 and 8/9. Accessory glands represented by oval pads filling the entire length of the segment and extending laterally to the b line of setae on each side in segments 15, 16, 17, and sometimes also in 19 and 20. Septa slightly thickened in the anterior genital region. Gizzard in segment 6. Last heart in segment 13. 2 pairs of elongated sperm sacs in segments 11 and 12; 2 pairs of large seminal funnels in segments 10 and 11; spermiducal glands leaf-like, with a very small duct hidden in the body-wall. Spermathecae with a sac-like ampulla and a small diverticulum opening into the distal end of the duct.

Length, 43-48 mms.; diameter, $3\frac{1}{2}$ mms.; number of segments, 120-123.

Locality: Donnybrook.

5. *Megascolex bistichus*, Michlsn.

Colour: dorsally brownish-violet, ventrally yellowish-gray. Head tanylobous (?). Setal rings with a regular mid-dorsal and mid-ventral break: $aa = 2ab$, $zz = 2aa$. First dorsal pore in furrow 5/6. Clitellum saddle-shaped covering segments (13) 14-18. Male pores in segment 18 close to the mid-ventral line on a large round papilla. Spermathecal pores, 2 pairs ventro-lateral in furrows 7/8 and 8/9. 4-6 pairs of small sucker-like hollows in furrows 19/20-24/25 in the b line of setae, causing small papilla-like projections into the body cavity. Septa $\frac{7}{8}$ -12/13 thickened. Gizzard in segment 6. 2 pairs of curved elongated sperm sacs in segments 11 and 12; 2 pairs of seminal funnels in segments 10 and 11; spermiducal glands tongue

like with a short narrow duct. Spermathecae with a pear-shaped ampulla merging into the duct ; a slender club-shaped diverticulum opens into the distal end of the duct.

Length, 45 mms. ; diameter, $2\frac{1}{2}$ mms. ; number of segments, 129.

Locality : Donnybrook.

6. *Megascolex monostichus*, Michlsn.

Colour, brownish-violet dorsally, yellowish-gray ventrally. Head epilobous (?) ; segment 1 with a broad mid-dorsal furrow (head tanylobous ?). Setal rings with a regular mid-dorsal and mid-ventral break : $aa = 2ab$ $zz = 2yz$. First dorsal pore in furrow 4/5. Male pores in segment 18 between the a and b lines of setae, on small papillae which are connected by a glandular ridge. Spermathecal pores, 2 pairs, in furrows 7/8 and 8/9 immediately lateral to the a line of setae. 10 or 11 small unpaired mid-ventral papillae in furrows 14/15 16/17 and 19/20-25/26 or 26/27. Gizzard in segment 6 (?). 2 pairs of slender sperm sacs in segments 11 and 12 ; spermiducal glands leaf-like and uneven with a very short narrow duct. Spermathecae with a duct which is almost as long as the short sac-like ampulla ; a club-shaped diverticulum opens into the distal end of the duct.

Length, 65-80 mms. ; diameter, $4\frac{1}{2}$ -5 mms. ; number of segments, 140-155.

Locality : Harvey.

7. *Megascolex torbayensis*, Michlsn.

Colour, reddish-brown or flesh-coloured dorsally, yellowish-gray ventrally. Head epilobous ; segment 1 with a mid-dorsal longitudinal furrow. Setal rings with a regular mid-dorsal and mid-ventral break : $zz = 2aa$, $aa = 2\frac{1}{2}$ -4 ab . First dorsal pore in furrow 4/5. Clitellum only developed dorsally, in segments 14-17. Male pores in segment 18 on small papillae between the a and b lines of setae. Spermathecal pores, 2 pairs in furrows 7/8 and 8/9, slightly lateral to the a line of setae. Accessory glands consist of a pair of small papillae between the a and b lines of setae in furrow 16/17, and a similar pair in line b in furrow 19/20. Septa in the region of the sperm sacs slightly thickened. Gizzard in segment 6 (?). 2 pairs of seminal funnels in segments 10 and 11 ; sperm sacs in segment 11 (and 12 ?) ; spermiducal gland leaf-like with a very short duct. Spermathecae slender and sac-like tapering distally ; a slender club-shaped diverticulum opens into the distal end.

Length, 55 mms. ; diameter, $3\frac{1}{2}$ mms. ; number of segments, about 105.

Locality : Torbay.

8. *Megascolex colliensis*, Michlsn.

Colour, chestnut brown with a violet tint in the head region ; ventrally yellowish ; the pigmentation is paler or lacking in the region of the setae. Head epilobous ; segment 1 with a mid-dorsal longitudinal furrow. Setal rings with a regular mid-dorsal and mid-ventral break : $aa = 1\frac{1}{2}$ -2 ab . First dorsal pore in furrow 3/4. Clitellum complete, covering segments 15- $\frac{1}{2}$ /17 or 17. Male pores in segment 18 on whitish papillae in the b line of setae. Spermathecal pores, 2 (or 3 ?) pairs in the b line of setae in furrows 7/8 8/9 (6/7 8/9 ?). Accessory glands variable ; maximum, 5 unpaired mid-ventral papillae anteriorly placed in segments 11, 17, 18, 19,

20 ; a pair of smaller papillae in the *b* line of setae in furrow 19/20 ; and 2 pairs of tiny papillae in the *a* line of setae in segment 18. Septa 7/8-13/14 thickened. Gizzard in segment 6 ; oesophagus without calciferous glands ; mid-gut begins in segment 17. Last heart in segment 13. Sperm sacs, 2 pairs in segments 11 and 12 ; 2 pairs of seminal funnels in segments 10 and 11 ; spermiducal glands disc-like with a short narrow duct. Spermathecae with a sac-like ampulla merging into the duct ; a club-shaped diverticulum opens into the distal region of the duct.

Length, 32-52 mms. ; diameter, 2-2½ mms. ; number of segments, 55-115.

Locality : Collie and Fernbrook (formerly Lumenberg).

9. *Megascolex albanysensis*, Michlsn.

Colour, brownish dorsally, yellowish-gray ventrally, the head end faintly red. Head epilobous ; segment 1 with a mid-dorsal longitudinal furrow. Setal rings, except at the head end, with regular mid-dorsal and mid-ventral breaks : $zz = aa - 2ab$. First dorsal pore in furrow 5/6. Clitellum complete but indistinct, covering segments 14-17 (or 18). Male pores in segment 18 on papillae between the *b* and *c* lines of setae. 2 pairs of spermathecal pores in furrows 7/8 and 8/9 in the *c* line of setae. Accessory glands feebly developed : 1 pair of small papillae or glandular spots in furrow 19/20 between the *a* and *b* lines of setae. Septa 7/8-15/16 thickened. Gizzard in segment 6 ; oesophagus without calciferous glands ; mid-gut begins in segment 17. Last heart in segment 13. 2 pairs of elongated sperm sacs in segments 11 and 12 ; spermiducal glands, small and leaf-like with a very small duct. Spermathecae with an almost spherical ampulla merging into a short duct ; a short club-shaped diverticulum opens into the distal end of the duct.

Length, 55-60 mms. ; diameter, 3½-3¾ mms. ; number of segments, 100-108.

Locality : Albany.

10. *Megascolex galei*, Michlsn.

Colour, violet-brown dorsally, the setae marked by pale spots, and yellowish or brownish-gray ventrally. Head tanylobous, the dorsal projection of the prestomium divided by a transverse furrow. Setal rings with a regular mid-dorsal and mid-ventral break : $aa - 2\frac{1}{2}ab - zz$. First dorsal pore in furrow 4/5. Male pores in segment 18 in the *b* line of setae on small papillae connected by a transverse glandular ridge. Spermathecal pores, 2 pairs in furrows 7/8-8/9 between the *b* and *c* lines of setae. A large transversely-oval glandular pad occupies the ventral surface in furrow 15/16, extending in mature specimens over the length of segments 15 and 16, in which case it is divided into 2 by the intersegmental furrow. Septa 9/10-12/13 slightly thickened. Gizzard in segment 6 ; calciferous glands lacking. 2 pairs of testes and seminal funnels in segments 10 and 11, free or embedded in masses of ripening sperm ; 2 pairs of slender curved sperm sacs in segments 11 and 12 ; spermiducal glands leaf-like with a short, slightly bent duct. Spermathecae with a pear-shaped ampulla merging into a duct the wall of which is very similar in structure to the ampulla ; a simple diverticulum opens into the distal end of the duct.

Length, 70-75 mms. ; diameter, 4-5½ mms. ; number of segments 143-157.

Locality : Collie.

11. *Megasclex collinus*, Michlsn.

Colour, dorsally chestnut-brown with a purple colouration in the mid-dorsal region; ventrally, yellowish-gray. Head epilobous. Setal rings with a regular mid-ventral break: $aa = 1\frac{1}{2} ab$. First dorsal pore in furrow 5/6 (?). Male pores in segment 18 on small papillae in the b line of setae. Accessory glands consist of 1 pair of small papillae in furrow 19/20 between the a and b lines of setae. Septa 7/8–14/15 thickened. Gizzard in segments 6 and 7; calciferous glands lacking. Last heart in segment 13. 1 pair of slender sperm sacs in segment 12 (a second pair in 11 ?); 2 pairs of seminal funnels in segments 10 and 11; spermiducal glands occupy segments 17 and 18 and are disc-like with a deeply grooved medial margin; duct s-shaped and equal in length to the glandular region. Spermathecae pear-shaped and flattened, tapering distally but without a definite duct; an extremely long, thin, irregularly-twisted diverticulum with a human which dilates proximally to form a small sperm chamber, opens into the distal end of the spermathecal ampulla.

Length, more than 30 mms.; diameter, 3 mms.; number of segments, more than 64.

Locality: Broome Hill.

12. *Megascolex longicystis*, Nicholls & Jackson.

1926. *Megascolex longicystis*, Nicholls & Jackson. Journ. Roy. Soc. Western Australia. Vol. XII. p. 142.

Colour, purplish-brown dorsally with a dark mid-dorsal stripe, and yellowish-white ventrally; the snout and posterior end are white tipped. Clitellum represented by a slightly paler band covering segments 14–18. Setal rings unbroken. Head epilobous; segment 1 with a mid-ventral longitudinal groove. First dorsal pore in furrow 4/5. Male pores in segment 18 on small papillae in the b line of setae. Spermathecal pores, 2 pairs on the anterior margins of segments 8 and 9 in the c line of setae. Gizzard in segment 6. Calciferous glands lacking. Last heart in segments 13. Sperm sacs, 3 pairs in segments 10, 11, and 12; spermiducal glands leaf-like with an s-shaped duct. Spermathecae pear-shaped with a diverticulum 5–6 times as long as the ampulla.

Length, 70–80 mms.; diameter, 3 mms.; number of segments, about 100.

Locality: Armadale and Wongong.

13. *Megascolex swarbricki*, Nicholls & Jackson.

1926. *Megascolex swarbricki*, Nicholls & Jackson. Journ. Roy. Soc. Western Australia, Vol. XII., p. 143.

Colour, dorsally greyish-brown, ventrally yellowish-white. Head tanylobous. Clitellum saddle-shaped, covering segments 13–19. First dorsal pore in furrow 4/5. Male pores in segment 18 medial to the a line of setae on an oval papilla which is grooved before and behind the pores. Spermathecal pores 2 pairs, extremely close together in small depressed areas in furrows 7/8 and 8/9. Accessory glands variable; usually 2–3 pairs of papillae in furrows 19/20–20/21 or 21/22, those forming the last pair, when present, closer together than those of the other pairs. Gizzard in segment 6; oesophagus with glandular dilatations in segments 10–14. Last heart in segment 13. 3 pairs of racemose sperm sacs in segments 10, 11, and 12; 2 pairs of

testes and seminal funnels in segments 10 and 11 ; spermiducal glands broad and leaf-like divided into 2 lobes by a deep groove on the medial side ; the duct opens into the posterior lobe of the glandular mass. Spermathecae elongated with a spherical head ; a club-shaped diverticulum opens into the short duct.

Length, 160 mms. ; diameter, 5 mms. ; number of segments about 188.

Locality : Nornalup.

14. *Megascolex syndetoporus*, Sp. nov.

Pl. XV., Fig. 1. Text-figs. 10, 11.

External features : Length, 105 mms. ; thickness, 6 mms. ; number of segments, 173.

Colouring : dorsally purplish-brown, ventrally creamy-white. The head is tanylobate, with a transverse furrow across the tapering base of the prestomium. There is also a suggestion of a longitudinal median furrow dividing the prestomium into two indistinct lobes.

The rings of setae have a regular mid-dorsal interruption. Ventrally and posterior to the clitellum they are also interrupted, but anterior to the clitellum the break is not apparent.

The first dorsal pore occurs between segments 4 and 5, except in one specimen, where there was a small pore at intersegment 3/4.

The clitellum is thick and saddle-shaped and covers segments 14-19, extending ventrally as far as the c line of setae. In some of the specimens segment 13 was also covered by a thin layer of clitellar tissue.

The male pore is unpaired and lies in segment 18 on a transversely elongated median papilla, the anterior and posterior margins of which tend to overhang the pore. Transverse sections show that the papilla is muscular in structure with a cluster of glandular patches embedded deeply in it.

The spermathecal pores are also unpaired, and lie in tiny oval depressions in the mid-ventral line between segments 7-8 and 8-9.

The accessory glands are mid-ventral in position and unpaired, and consist of fairly large rounded papillae each with a glandular core which is rather clearer in appearance than the surrounding tissue. The number of these glands which may be present seems to be extremely variable, and may be as many as seven ; three before the male pores, at intersegments 14/15-16/17, and four after, at intersegments 19/20-22/23 (this number occurs in the majority of the specimens taken and probably forms the normal condition), or they may be reduced to one or two before and one, two, or three after the segment of the male pores. In no case, however, do they occur at intersegments 17/18 or 18/19.

Anatomy : The gut has a large gizzard in segment 6. The oesophagus has no calciferous glands, but in each of segments 10-14 (in one case 10-15) it is thicker walled and swollen and has a rich blood supply. The mid-gut is thin walled and wide and begins in segment 17.

Micronephridia occur throughout the length of the body. In segment 3 they are very numerous and are clustered together so as to form a tuft on each side of the gut. These apparently function as peptonephridia for transverse section showed traces of ducts on each side leading towards the ventral surface of the gut.

Male reproductive organs : There are two pairs of sperm-duct-funnels in segments 10 and 11. These two segments are filled with a mass of sperm

morulae which must be removed before the funnels or sperm sacs can be seen. Of the latter there are three pairs, each sac being rather elongated and finger-like with a somewhat broken surface. They project from septa 9/10, 10/11 and 11/12 into segments 10, 11 and 12. Those in segment 10 are smaller than those in either of the other two segments. The spermiducal glands are large, thick, and flattened, and open to the exterior through very short straight muscular ducts which are barely longer than the thickness of the body-wall, and which lead to a common median pore.

The female reproductive organs are of the usual type and structure with ovaries and oviducal funnels in segment 13.

There are two pairs of spermathecae. They are large and sac-like, with a wide neck into the base of which opens a club-shaped diverticulum. This diverticulum varies in length from slightly less than, to about two-thirds that of the main body of the spermatheca. A narrow duct leads to the exterior, the two ducts in each of segments 8 and 9 opening by a common median pore at intersegments 7/8 and 8/9.

Locality : Pemberton.

15. *Megascolex albidus*, Sp. nov.

Pl. XV., Fig. 2. Text-fig. 12.

Only two specimens of this worm, both mature, were collected. External features : length (after preservation in spirit) 75 mms. ; breadth, 3 mms. ; number of segments, 130.

Colouring : In spirit they are creamy-white and unpigmented, with a light brown clitellum.

The head is pro-epilobous. The prostomium projects backwards through about half the length of the peristomium, which is itself further divided by a mid-dorsal and a mid-ventral longitudinal groove.

The setal ring has a regular break both dorsally and ventrally. *aa* is roughly equal to 2 *bc*, while the setae *a* and *b* are slightly closer together than the others of the ring. The setae themselves are sigmoid, and slightly ornamented, having a group of tiny longitudinally arranged lines in the region of the nodulus. A few of the setae which were taken from segments a little posterior to the male genital region were marked by the presence of a slight notch in front of the nodulus. These notched setae had also slight markings both near the tip and posterior to the nodulus.

The first dorsal pore occurs between segments 4 and 5.

The clitellum is saddle-shaped and very sharply defined. It covers segments 13-18 dorsally, and 14-17½ ventrally, extending as far as setal line *b*.

The male pores are on a pair of rounded papillae on segment 18. The pores themselves are between the *a* and *b* lines setae, and the papillae so close as to merge into each other by a narrow neck. Around and between these papillae the surface is depressed, and surrounding the whole is a well defined wall.

The female pores are in segment 14, slightly anterior to the setal ring. The spermathecal pores are rather slit-like, and lie in the *a* line of setae in furrows 7/8 and 8/9.

There are no other genital markings.

Anatomy : The septa from 9/10 to 14/15 are all slightly thickened.

Gut : There is a well-developed gizzard in segment 6. The oesophagus is marked by vascular swellings in segments 11 to 17, those in segments 13 and 17 being the largest. The mid-gut, which has no typhlosole, commences in segment 19.

Nephridial system : Micronephridia occur. They are arranged in lines which encircle the body in each segment.

Circulatory system : The last heart is in segment 13.

Male organs : There are three pairs of sperm sacs. They are flattened and rather fanlike structures occurring in segments 10, 11 and 12, those forming the last pair being the smallest. The testes could not be made out, but there is a pair of free funnels in each of segments 10 and 11. The margins of the funnels seem to be divided into three lobes with extremely long fringing cilia. The spermiducal glands in segment 18 are thick and flat and almost pear-shaped, with a very short duct. There are no penial setae, though those surrounding the male genital field seem to be slightly shorter and stouter than the rest and there are two in each sac.

Female organs : The ovaries are in segment 13. They are exceptionally large and are divided into a number of moniliform branches. This condition is probably merely due to the extreme ripeness of the ovary.

The spermathecae are large and ampulla-shaped, with the head bent slightly to one side. The diverticulum is slender and straight and is about half as long as the main body.

Locality : Condinup.

7. Genus *PHERETIMA*, Kinb.

More than 8 setae per segment. Spermathecal pores 1-6 pairs between segments 3-9. 1 gizzard in segment 8 or between septa 7/8 and 10/11. Micronephridial. Seminal funnels contained in sperm reservoirs. Spermiducal gland with a branching lumen. Penial setae do not occur.

South-east Asia, Malay Archipelago, Australia.

Pheretima heterochaeta, (Beddard).

Text-figs. 13, 14, 15.

Colour, brownish. Head epilobous. Setae of segment 10 smaller than those of the neighbouring segments. Clitellum complete, covering segments 14-16. Male pores on papillae in segment 18. Spermathecal pores 4 pairs in furrows 5/6-8/9; small glandular papillae occur medial to the spermathecal pores in segments 7 and 8, sometimes also in 6 and 9. Septa 8/9 and 9/10 lacking. Gut with a pair of simple diverticula. 2 pairs of sperm reservoirs, those in segment 10 communicating with each other, those in segment 11 united; 2 pairs of sperm sacs in segments 11 and 12; spermiducal glands more or less rudimentary, with a curved duct. Spermathecae with a pear-shaped ampulla, a moderately long narrow duct, and a club-shaped diverticulum.

Length, 60-160 mms.; diameter, 3-4 mms. or more; number of segments, 91-100.

Locality : Perth and Boyanup.

Distribution : Hawaii, Japan, New Caledonia, New South Wales, India, Madagascar, Europe, Azores, Columbia, Florida, Georgia, California.

Remarks : This species has been recorded by Michaelsen (1907) from an orchard at Boyanup. One only of the three specimens collected by him

showed distinct glandular development, two pairs of small papillae occurring in the normal position, that is anterior to the setae and slightly medial to the spermathecal pores in segments 7 and 8.

Numerous specimens may readily be taken at the Government Gardens, Perth, but these show a considerable variation in the glandular arrangement. The majority have six pairs of papillae; three pairs on the anterior third of segments 7-8-9, and three pairs of very small papillae placed more anteriorly still on the same three segments immediately ventral to the last three spermathecal pores on each side. Any one, two, or more of these papillae may be present, or they may be lacking entirely. The glands underlying the larger papillae project into the body-cavity in the form of a flat bilobed fan.

There is no spermiducal gland. The vasa deferentia merge into stout muscular ducts which open on papillae in segment 18. In dissections a glandular mass can be seen above each male pore, and in one specimen a pair of small papillae occurred in the ventral surface, also slightly anterior to the male pores. Serial sections were made of this specimen and it was seen that the necks of the glands of this mass are elongated and open at the apex of the small papilla. This condition—two pairs of papillae on segment 18—is similar to that in *Ph. perkinsi* Bedd., and may perhaps be taken as offering a little support to Michaelsen's statement (1907) that there is no ground for the separation of the *perkinsi* forms as was suggested by Ude. It is true the condition only occurred in one specimen, but the underlying glandular mass was present in all cases. It is probable that the mass is prostatic, the papillae appearing only when the glands are functional.

The lymph glands are large and conspicuous and agree with the description made by Thapar (1918), but the coelomic organs of Beddard and Fedarb, referred to by Thapar in the same paper, could not be distinguished in any of the eight or nine specimens dissected.

The length of the diverticulum of the spermatheca is variable: it may be short and stunted or nearly twice as long as the main pouch, and in all the specimens examined was infested by *Monocystis*. It is possible that this variation may be a distortion due to the presence of the parasite, though normally *Monocystis* has no effect on the tissues of its host. On the other hand *Pheretima heterochaeta* is known to be a very variable species, though one would expect to find it constant at least for a definite locality.

Specimens differing from the type species have also been recorded by Stephenson (1914 and 1922) and Gates (1926).

3. SUB-FAMILY OCNERODRILINAE.

Genus *KERRIA*. Beddard.

Male pores in segment 18; pores of the spermiducal glands, 2 pairs in segments 17 and 19; spermathecal pores, usually 2 pairs in furrows 7/8 and 8/9, the former sometimes lacking. 1 gizzard in segment 7, or none; 1 pair of oesophageal pouches in segment 9. Spermiducal glands, 2 pairs (rarely double); 1 pair of testes in segment 10 (testes unknown in some species); Spermathecae usually without a diverticulum, rarely with a distal sacculation to the ampulla.

Subtropical South America, Lower California, and South-West Australia.

Kerria nichollsi, Sp. nov.

Pl. XVI., Figs. 5, 8, 9, 11.

External features : length, 55-70 mms. ; breadth, 1.5 mm. ; number of segments about 112.

In life the worm is colourless or of a creamy flesh-colour, with a yellowish clitellum and an unpigmented body wall through which the red blood can be seen. The nephridia are also visible through the skin, looking like a row of white patches down each side. After preservation in formalin the specimens often appear gray owing to the dark nature of the contents of the gut.

The head is zygalobous.

The setae, which are of the normal sigmoid type, are arranged in four pairs in each segment so that $aa = bc$ and $dd < \frac{1}{2}u$. The clitellum is saddle-shaped and covers segments 14-20. The male genital area forms a four-sided field on the ventral surface of segments 17-19. On each of segments 17 and 19 is a pair of large rounded glandular papillae lying immediately lateral to the b line of setae. The ducts of the four spermiducal glands open through these papillae on the walls nearest the ventral-median line, the first pair of pores being slightly anterior, the second slightly posterior to the axis passing through the centres of the papillae in each segment. The apices of the glandular papillae on each side are connected by a seminal groove which has a slight convex curve towards the mid-ventral line. The male pores lie in the b line of setae, in segment 18, and open into the most ventral point of the curve of the seminal grooves.

The spermathecal pores lie between segments 7-8 and 8-9, slightly below the c line of setae.

Anatomy : Septa 5/6-11/12 are thickened, the first and last only slightly so, but septa 6/7-10/11 are extremely strong. All of these septa are often distorted and thrown into folds and are connected to the body-wall by very thick muscular strands. Septal glands occur on septa 5/6-8/9 and take the form of large irregular masses of glandular tissue.

Gut : The buccal cavity leads to a pharynx which is lined dorsally by tall ciliated columnar cells and which has one or two short arms penetrating the pharyngeal mass. The gizzard, which in dissection has a clear almost transparent appearance, occupies segment 7. It is not very large and does not overlap either of the neighbouring segments. In structure it is thick-walled and muscular, but the entire oesophagus is very strong and in section sometimes resembles a chain of small gizzards. In segment 9 the oesophagus is thinner walled and has a pair of long somewhat ventrally-placed forwardly-directed, pear-shaped pouches with walls of large closely packed cells having a rich blood supply. These oesophageal pouches vary slightly in size in the different specimens and may be so large as almost to fill the entire segment. From segment 9 onwards the oesophagus has a ciliated lining. The mid-gut begins about half-way through segment 12.

The last heart is in segment 11.

The nephridial system is meganephric, the first nephridium occurring in segment 9. In structure each nephridium consists essentially of a coiled duct surrounded by a mass of large loosely bound cells, the nuclei of which stain very readily in borax carmine.

Male reproductive organs : There is only one pair of rather elongated testes projecting from septum 9/10 into segment 10, and a corresponding pair of spermiducal funnels leading back through septum 10/11 into the sperm ducts, which open to the exterior in segment 18 independently of the spermi

ducal glands. There are two pairs of sperm sacs in segments 9 and 11 and a certain amount of developing sperm matter lying freely in segment 10. The spermiducal glands consist of four long slender thread-like tubes extending through segments 15-21. They have moderately long muscular ducts which open to the exterior immediately lateral to the *b* setae in segments 17 and 19. The glandular region of each is typical of the Ocnetrodrilinae and consists of narrow lumen surrounded by a single layer of gland cells.

The female reproductive organs are normal. There is a pair of extremely large ovaries in segment 13, with obliquely placed oviducal funnels leading through septum 13/14 to open to the exterior in segment 14 in the *b* line of setae. The ova are spherical, and when ready to be freed from the ovary measure .05 mm. in diameter.

The spermathecae have a sac-like head and a thick-walled duct and are without a diverticulum. The relative lengths of the head and the duct appear to vary quite considerably, and when the duct is proportionately long it has a tendency to twist—this condition was only found in one specimen.

Locality : South Perth, in swampy ground near the margin of the Swan River.

Distribution : South America and South-west Australia.

Remarks : The species approaches most closely to *K. garmani* of Central Paraguay, but differs in the setal distances, the shape of the spermathecae and the length of the spermiducal glands. It is the first of the Ocnetrodrilinae to be recorded from Western Australia, and has been named after the collector, Professor Nicholls.

12. FAMILY LUMBRICIDAE.

KEY TO THE GENERA OF LUMBRICIDAE.

- | | | | |
|----|---|--|------------------------|
| 1. | { | Gizzard confined to 1 segment; spermathecal pores between the <i>d</i> line of setae and the mid-dorsal line | 1. <i>Eiseniella</i> . |
| | | Gizzard extending through 2-4 segments -2. | |
| 2. | { | Testes and seminal funnels free—3. | |
| | | Testes and seminal funnels usually enclosed in sperm reservoirs, rarely in incomplete coelomic chambers formed by the growing together of the septa or by strands of tissue; in latter case more than 3 pairs of spermathecae occur—4. | |
| 3. | { | Spermathecal pores single, near or in the mid-dorsal line ... | 2. <i>Eisenia</i> . |
| | | Spermathecal pores sometimes lacking, usually single in or beneath the <i>d</i> line of setae, sometimes in groups partly in and partly above line <i>d</i> | 3. <i>Helodrilus</i> . |
| 4. | { | Testes and seminal funnels enclosed in a median unpaired sperm reservoir; 3 pairs of sperm sacs in segments 9, 11, 12; 2 pairs of spermathecae | 5. <i>Lumbricus</i> . |
| | | Testes and seminal funnels enclosed in paired sperm reservoirs or in incomplete coelomic chambers in which case there are as a rule more than 2 pairs of spermathecae; 4 pairs of sperm sacs | 4. <i>Oetolasion</i> . |

1. Genus EISENIELLA Michlsn.

Head usually epilobous. Setae of each pair close together. Clitellum begins in segment 23 or further forward and covers 4-8 segments. Male pores in segment 15, or 2 or 3 segments earlier; spermathecal pores, 2 pairs between the *d* line of setae and the mid-dorsal line. Gizzard in segment 17. Testes and seminal funnels project freely into the body-cavity; 4 pairs of sperm sacs in segments 9-12.

Syria, Palestine, Europe, Azores, Canary Is., North America, Chile, Cape of Good Hope, New Zealand, New South Wales, Western Australia.

1. *Eiseniella tetraedra* (Sav.) forma typica.

Head epilobous. Middle and posterior regions of the body four-sided. Setae : $aa = bc$, dd slightly greater than bc . First dorsal pore in furrow $4/5$. Clitellum covers segments 22 or 23—26 or 27, the glandular walls extending over segments 23 or $\frac{1}{2}23$ —25 or 26. Male pores in segment 13 with thickened glandular margins.

Length, 30–50 mms. ; diameter, 3–4 mms. ; number of segments, 70–90.

Locality : Albany.

Distribution : North America, Chile, Azores, Canary Is., Europe, Palestine, Syria, Cape of Good Hope, New Zealand, New South Wales, Western Australia.

2. *Eiseniella intermedius*, Sp. nov.

Pl. XVI., Figs. 4, 6, 7. Text-fig. 16.

External features : length, 50 mms. ; breadth, 2.5 mms. ; number of segments, 72.

Colouring : Brown anteriorly and dorsally, but posterior to the clitellum which in life is orange coloured, the brownish tint is confined to a narrow median band. Ventrally the colour fades to a light yellowish brown.

The head is epilobous and the body rounded, with the exception of the posterior third, which is four-sided.

The setae are of the simple sigmoid type and are arranged in four pairs on each segment, aa being equal to about $3ab$, ab to cd , and dd measuring slightly less than $\frac{1}{2}u$. The distance between the pairs of setae becomes greater posteriorly so that the body when seen in transverse section has a rectangular shape. In *Eiseniella tetraedra* this rectangular condition also occurs, but the region is not so limited and embraces both the mid and hind-body. The two ventral pairs of setae in segment 10 are enclosed in greatly elongated muscular sacs which open to the exterior by cup-like pits in the body-wall. These four genital setae are about twice the length of the normal setae, and are more sharply pointed, with immediately behind the sharp tip, a swollen apex which tapers away to a slender waist-like region, the seta becoming the thicker and stronger again at the base.

Dorsal pores are present, the first occurring between segments 5 and 6.

The clitellum extends over segments 22–27, differing from the arrangement normally prevailing in the lumbricidae in being complete, though much thicker dorsally and laterally than ventrally. The glandular walls lie between setal lines b and c extending over a distance equal to the length of three segments from $\frac{1}{2}23$ to $\frac{1}{2}26$. The segments 19, 20, and 21 have each a ventral pair of glandular swellings indistinguishable in colour from the rest of the body. They resemble rather elongated papillae, the pair on segment 19 being the largest.

The male pores open into transversely elongated grooves with thickened lips, which lie between the setal lines b and c in segment 13. In one specimen one of these pores was found to open on segment 12, the other being normal in position.

The female pores open on segment 14 in the setal line a but they cannot be made out without having recourse to serial sections.

The spermathecal pores, of which there are two pairs, are large and conspicuous, and lie in intersegments $9/10$ and $10/11$, between setal line d and the mid-dorsal line.

Anatomy : The septa 6/7 to 12/13 are slightly thickened.

Gut : The pharyngeal mass of glandular muscular tissue extend back as far as segment 7. There is a lateral pair of calciferous glands in segment 10. The wall of the gut itself, from the region immediately behind the calciferous glands in segment 10 to the end of segment 13 is of the type usually associated with the oesophagus of the Lumbricidae : extremely thick, divided into a number of lacunae by longitudinal muscle strands each strand being penetrated by blood vessels, and with a ciliated internal lining. Cilia also occur in the dorsal branch of the pharynx which penetrates the pharyngeal mass. Segments 15 and 16 are occupied by the crop. This is followed by a single gizzard. It is difficult to determine whether the gizzard occupies one or two segments. In dissection it would appear to occupy only segment 17 though forcing septum 17/18 back so as it appears to lie also in segment 18. Serial sections seem to indicate that it occupies both of these segments though tapering away in the latter. In one specimen serial sections showed a dorsally directed fold on each side of the wall of the mid-gut as though this has been pulled up by the tightened septa. Sections cut of a second specimen did not show these folds, which suggests that they are probably merely due to distortion during fixation. A typhlosome occurs.

Circulatory System : The last heart is in segment 11. Both the hearts and the dorsal vessel in this region are extremely thick-walled and strong, the cells of the wall appearing to have a glandular nature.

Nephridial System : The nephridia are of the normal meganephric type consisting of a loosely bound tube with a muscular duct.

Male Reproductive Organs : There are two pairs of testes and funnels projecting freely into the body cavity in segments 10 and 11. In the specimen sectioned there seemed also to be a small mass of testis-like tissue projecting forward into segment 9. The vasa deferentia are much convoluted and the first pair, after passing back through one segment enter the body wall and lie just within the longitudinal muscle layer. The two vasa deferentia on each side eventually unite and open to the exterior through a pore which is situated at the end near the setal line *c* of the male genital groove in segment 13. As usual in the Lumbricidae there is no prostate, but the ventral body-wall in this region is extremely glandular, the glands seeming to be directed rather towards the ventrally placed end of the genital groove. This glandular nature of the body-wall, more particularly of the inner surface of the longitudinal muscle layer is noticeable as far forward as segment 8, and continues to the end of segment 14. There are four pairs of sperm sacs in segments 9–12, those in segment 10 being rather smaller than the rest. The septum 12/13 also has two sacs which project into segment 13, and seem to be of the same nature as sperm sacs, but in all the specimens examined they were merely empty pouches of septal tissue—with one exception, and in that case the sperm sac from segment 12 was extremely large and had pushed back in to the empty sac.

Female Reproductive Organs : The type and arrangement of these are normal. The ovaries are in segment 13, into which the richly ciliated oviducal funnel projects through septum 13/14. The duct opens to the exterior in segment 14 in the *a* line of setae.

The spermathecae are of the typical lumbricid type : rounded, almost spherical bodies with a short strong duct, and without a diverticulum.

Locality : Numbers of this worm were taken from the fresh water along the margin of Monger's Lake.

Remarks : The species seems in some respects to lie between the genera *Eiseniella* and *Eisenia*, both of which are represented in this State and were recorded (*Eiseniella tetraedra* and *Eisenia foetida*) from Albany by Michaelsen in 1905. The chief distinction between it and *Eiseniella* is the position of the last pair of spermathecal pores, which lie one segment further back in the species here described, that is, between segments 10 and 11, as in *Eisenia*. The position of the last pair of spermathecal pores seems hitherto to have been one of the most constant features of all members of a genus, and the condition in the present case may have sufficient taxonomic value to justify the establishment of a new genus. But for the present, lacking other related species, it is convenient to include it in the very closely related genus *Eiseniella*.

It may be noted that one specimen disagreed from the rest in that in the clitellum covered segments 18-22, and the male pore was in segment 8.

<i>Eiseniella.</i>			Sp. nov.	<i>Eisenia.</i>	
Head	...	...	Epilobous	...	Epi- or Tanylobous.
Setae	...	...	Close together. Ventre-lateral and dorso-lateral	Mod. far apart. Ventre-lateral and lateral	Close, moderately far, or far apart.
Clitellum	...	...	Segment 23 or earlier and covering 4-8 segments	Segments 22-27	Segments (23-27) to (30-34).
Male Pore	...	...	Segment 15, or 2 or 3 segments more anterior	Segment 13	Segment 15.
Spermathecal Pores	2 pairs ; between <i>d</i> and mid-dorsal line at furrows 8/9 and 9/10		2 pairs ; between <i>d</i> and mid-dorsal line at furrows 9/10 and 10/11	2 or 3 pairs; above <i>d</i> and near to or in the mid-dorsal line, at furrows 8/9 or 9/10-10/11.	
Gizzard	...	...	Segment 17	Segment 17 and 18	Continues through more than one seg- ment.
Testes and Funnel	Free	...	Free	...	Free.
Sperm Sacs	...	4 pairs in segments 9-12	4 (+ 1) in segments 9-12 (13)	3 or 4 pairs in 9, 11, and 12, or 9-12.	

2. GENUS EISENIA Malm.

Head epi or tanylobous. Male pores in segment 15 ; spermathecal pores, 2 or 3 pairs in furrows 8/9-10/11 or 9/10 and 10/11, very close to or in the mid-dorsal line. Gizzard extends through more than 1 segment. Testes and seminal funnels not contained in sperm reservoirs ; 3 or 4 pairs of sperm sacs in segments 9, 11 and 12, or 9-12.

Siberia, Palestine, Syria, Armenia, Europe, North Carolina, Georgia. A few species are cosmopolitan.

Eisenia foetida, Sav.

Text-fig. 17.

In life, each segment with a red brown or purple band, the colour fading away ventrally ; lateral regions of segments 9-11 also devoid of pigments. Head epilobous. Setae ornamented ; $aa - bc$, $dd = \frac{1}{2}u$. First dorsal pore in furrow 4/5. Clitellum covers segments 24, 25, or 26-32, the glandular walls extending from 28 or $\frac{1}{2}28$ 30 or 31. Spermathecal pores, 2 pairs in furrows 9/10 and 10/11 near the mid-dorsal line.

Length, 60-90 mms. ; diameter, 3-4 mms. ; number of segments 80-110.

Locality : Kalgoorlie, Monger's Lake and Albany.

Distribution : Almost cosmopolitan.

Remarks : It is not possible with the available literature to be quite certain of the species to which the specimens from Kalgoorlie and Monger's Lake belong. They agree with the description made by Michaelsen in "Das Tierreich" (given above) except that the setal distance aa is slightly greater than bc , and dd , anterior to the clitellum, is greater than $\frac{1}{2}u$. Also, in his brief account, no mention is made of the fact that each pair of ventral setae in the clitellar region is surrounded by a whitish rectangular patch. In transverse section it is seen that these patches are caused by the presence of cup-like orifices through which the setae project. This same condition is found in the lateral setal-bundles of the testes segments.

In many of the specimens collected occasional segments were incomplete, and this caused asymmetry of the organs, the spermathecae and spermiducal funnels, etc., lying one segment further back on one side than on the other.

When the living specimens were plunged into spirit a quantity of yellow matter was extruded through the dorsal pores. This coelomic fluid consisted of numerous small masses of tiny spherical globules.

Numerous specimens were found at Monger's Lake in September, 1926. Some were gathered together under an old piece of sacking, while others were entangled in the roots of weeds at the water's edge. This agrees with the account given by W. W. Smith (1894) of the habit of these worms, then known as *Allobophora foetidus*, of depositing cocoons under flat stones, wood, or old bags, the deposition taking place from August to December.

3. GENUS HELODRILUS. Hoffm.

Head usually epilobous. Male pores in segment 15 ; spermathecal pores sometimes lacking, usually single in or below the d line of setae, sometimes in groups in and above line d . Gizzard extends through more than one segment. Testes and seminal funnels project freely into the body cavity.

Asia, Europe, Africa, islands of the Atlantic, North and South America, Hawaii, New Zealand, Australia.

1. *Helodrilus (Allobophora) caliginosus* Sav.

Head epilobous. Setae $aa > bc$, $dd = \frac{1}{2}u$. First dorsal pore in furrow 8/9 or 9/10. Clitellum saddle-shaped covering segments 27 or 28-34 or 35 ; glandular tubercles 2 pairs in segments 31 and 33 or united to form walls which extend over segments 31-33 or 34. Lips of the male pores thick and glandular ; spermathecal pores, 2 pairs in furrows 9/10 and 10/11 in the setal line

cd. Setae *ab* of segments 9, 10, and 11 usually on wide papillae and modified as genital setae. Septa 5/6–9/10 thickened. Sperm sacs small in segments 9 and 10.

Length, 60–160 mms. ; diameter, 4–5 mms. ; number of segments, 104–248.

Locality : Very common all over the south-west of Australia.

Distribution : Nearly cosmopolitan.

2. *Helodrilus (Bimastus) parvus*, Eisen.

Colour, reddish-brown. Head epilobous. First dorsal pore in furrow 5/6. Clitellum saddle-shaped covering segments 24–30, the glandular walls being indistinct and extending over segments 25 or 26–29 or 30. Male pores with small but distinct lips. Sperm sacs racemose and compressed in segments 11 and 12. Spermathecae lacking.

Length, 25–40 mms. ; diameter, 1–2 mms. ; number of segments, 85–111.

Locality : Mundaring Weir.

Distribution : North America, Argentine, Cape of Good Hope, St. Paul, Tibet, Australia.

Remarks : A single specimen found by Michaelsen at Mundaring Weir is the only representative of the species that has hitherto been found in Australia.

3. *Helodrilus (Bimastus) constrictus*, Rosa.

A red pigmentation occurs dorsally. Head epilobous. Setae : *bc* > *cd*, *cd* > *ab*. First dorsal pore in furrow 5/6. Clitellum covers segments 26–31 ; glandular walls lacking. Male pores with distinct glandular margins. Setae *ab* in segment 16 usually on broad indistinctly-marginated papillae.

Length, 20–30 mms. ; diameter, 3 mms. ; number of segments, 90–105.

Locality : Cranbrook and Albany.

Distribution : North and South America, Europe, South Siberia, Unalaska, Hawaii, South-west Australia.

BIBLIOGRAPHY.

Bage.

- 1909—Contributions to our knowledge of Australian Earthworms : The Nephridia. *Proc. Roy. Soc. Victoria*. Vol. XXII. Pt. II.

Beddard.

- 1891—Abstract of some Investigations into the Structure of the Oligochaeta, *Ann. Mag. Nat. Hist.* p. 92.
 1895—A Monograph of the Order Oligochaeta.
 1899—On a Collection of Earthworms. *Zool. Results*. Pt. II.
 1903—The Earthworms of the Maldiv and Laccadive Islands. *Fauna and Geography of the Maldiv and Laccadive Archipelagoes*, Vol. I. Pt. IV.

Benham.

- 1907—On the Oligochaeta from the Blue Lake, Mount Kosciusko. *Rec. Austr. Mus.* VI.
 1922—Oligochaeta of Macquarie Island, Aust. Antarctic Exped. 1911–14. *Scientific Reports*, Series C. Vol. VI. Pt. 4.

Buchanan.

- 1909—Notes on the Accessory Glands of *Cryptodrilus saccarius* (Flech.). *Proc. Roy. Soc. Victoria*, Vol. XXII. Pt. II.
 1909—Contributions to our Knowledge of Australian Earthworms ; The Blood Vessels, Parts I. and II. *Proc. Roy. Soc. Victoria*.

Dixon.

- 1915—Tubifex. *L.M.B.C. Memoirs XXIII*.

Gates.

- 1926—Notes on Earthworms from various places in the province of Burma, with description of two new species. *Rec. Ind. Mus.* Vol. XXVIII. Pt. III.

Goddard.

- 1908—Contributions to a further Knowledge of Australasian Oligochaeta, Parts I. and II. *Proc. Linn. Soc. N.S.W.* Vol. XXXIII. Pt. 4.

Harrison.

- 1926—Crucial Evidence for Antarctic Radiation. *Amer. Nat.* Vol. LX.
 1926—The Wegener Hypothesis from a Biological Standpoint. *Sydney Univ. Sci. Journ.* Vol. X. No. 1.

Michaelsen.

- 1900—Oligochaeta. *Das Tierreich*, Lief. 10.
 1905—Oligochaeta. *Die Fauna Sudwest-Australiens* Band 1, Lief 2.
 1908—Oligochaeten von Natal und dem Zululand. *Arkiv. for Zoologi*, Band 4 Häfte 1–2.
 1909—The Oligochaeta of India, Nepal, Ceylon, Burma, and the Andaman Islands. *Mem. Ind. Mus.* Vol. 1. No. 3.
 1913—Oligochaeten vom Kenia-Distrikt in Britisch Ostafrika, gesammelt von der Schwedischen Zoologischen Expedition 1911. *Arkiv for Zoologi* Band 7. Häfte 4.
 1916—Oligochaeten aus dem Naturhistorischen Reichsmuseum zu Stockholm. *Arkiv for Zoologi* Band 10, Häfte 1–2.
 1921—Neue und wenig bekannte Oligochaeten aus skandinavischen Sammlungen. *Arkiv for Zoologi*. Band 13, Häfte 3–4.
 1921–22—Sammlungen der Schwedischen Elgon-Expedition im Jahre 1920 : 2 Oligochaeten. *Arkiv for Zoologi*. Band 14 Häfte 3–4.

Nicholls.

- 1922—*Dero roseola* *Journ. Roy. Soc. Western Australia* Vol. VII.

Nicholls and Jackson.

- 1926—Some New Species of Megascolex from South-Western Australia. *Journ. Roy. Soc. Western Australia* Vol. XII.

BIBLIOGRAPHY—continued.

Raff.

- 1909—Contributions to our knowledge of Australian Earthworms: The Alimentary Canal. Part I. *Proc. Roy. Soc. Victoria* Vol. XXII. Pt. II.

Shannon.

- 1920—On the Structure of a New Species of Earthworm from South Australia. *Megascolex fletcheri*. *Proc. Roy. Soc. Victoria* Vol. XXXII. Pt. II.

Smith.

- 1894—*Trans. N.Z. Inst.* Vol. XXV.

Spencer.

- 1888—The Anatomy of *Megascoloides australis*. *Trans. Roy. Soc. Victoria* Vol. I. Pt. I.
 1892—Preliminary Notice of Victorian Earthworms: Part II. The Genus *Per-richaeta*. *Roy. Soc. Victoria*.
 1896—*Acanthodrilus eremius*, a New Species of Earthworm. *Report of the Horn Expedition to Central Australia* Part II.

Stephenson.

- 1909—The Anatomy of some aquatic Oligochaeta from the Punjab. *Mem. Ind. Mus.* Vol. I. No. 3.

Stephenson.

- 1910—Studies on the aquatic Oligochaeta of the Punjab. *Rec. Ind. Mus.* Vol. V. Pt. I.
 1914—On a collection of Oligochaeta mainly from Northern India. *Rec. Ind. Mus.* Vol. X. Pt. VI.
 1914—Littoral Oligochaeta from Chilka Lake on the east coast of India. *Rec. Ind. Mus.* Vol. X. Pt. IV.
 1914—Zoological Results of the Abor Expedition 1911–12. Pt. IV. *Rec. Ind. Mus.* Vol. VIII.
 1915—On some Indian Oligochaeta mainly from Southern India and Ceylon. *Mem. Ind. Mus.* Vol. VI. No. 1.
 1915—Fauna of the Chilka Lake No. 1. *Mem. Ind. Mus.* Vol. V.
 1916—On a collection of Oligochaeta belonging to the Indian Museum. *Rec. Ind. Mus.* Vol. XII. Pt. VII.
 1917—On a collection of Oligochaeta from various parts of India and Further India. *Rec. Ind. Mus.* Vol. XIII. Part VI.
 1920—On a collection of Oligochaeta from the lesser-known parts of India and from Eastern Persia. *Mem. Ind. Mus.* Vol. VII. No. 3.
 1921—Oligochaeta from Manipur, the Laccadive Islands, Mysore, and other parts of India. *Rec. Ind. Mus.* Vol. XXII. Pt. V.
 1922—Some Earthworms from Kashmir, Bombay, and other parts of India. *Rec. Ind. Mus.* Vol. XXIV. Pt. IV.
 1924—On some Indian Oligochaeta, with a description of two new genera of Oenodrilinae. *Rec. Ind. Mus.* Vol. XXVI. Pt. IV.
 1925—On some Oligochaeta mainly from Assam, South India, and the Andaman Islands. *Rec. Ind. Mus.* Vol. XXVII. Pt. II.
 1926—Description of Indian Oligochaeta I. *Rec. Ind. Mus.* Vol. XXVIII. Pt. IV.

Sweet.

- 1900—On the Structure of the Spermiducal Glands and Associated Parts in Australian Earthworms. *Linn. Soc. Journ. Zool.* Vol. XXVIII.

Thapar.

- 1918—The Lymph Glands in the genus *Pheretima*, with a note on the coelomic organ of Beddard. *Rec. Ind. Mus.* Vol. XV. Pt. II.

Welch.

- 1914—Studies of the Enchytraeidae of North America. *Bull. Illinois State Lab. of Nat. Hist.*

EXPLANATION OF PLATES.

PLATE XIV.

- Fig. 1. Diagram of the ventral aspect of *P. bermudensis* Bedd. Forma *ephippiger* Rosa, as found at Cottesloe.
2. Diagram of the ventral aspect of *P. albanyensis* Mehlsn. var. **cygni** var. nov.
3. Spermatheca of same.
4. Distal end of seta of same.
5. Spermiducal gland of *P. bermudensis* Bedd. forma *ephippiger* Rosa.
6. Distal end of notched seta from same.
7. Spermatheca of *P. albanyensis* Mehlsn.
8. Spermiducal gland of same.
9. Spermiducal gland of *P. albanyensis* Mehlsn. var. **cygni** var. nov.

PLATE XV.

- Fig. 1. Spermatheca of **Megascolex syndetoporus** sp. nov.
2. Spermatheca of **Megascolex albidus** sp. nov.
3. Spermatheca of **Notoscolex leios** sp. nov.
4. Spermatheca of **Plutellus varicystis** sp. nov.
5. Distal tip of penial seta of **Notoscolex leios** sp. nov.
6. Spermatheca of **Kerria nichollsi** sp. nov.
7. Distal tip of penial seta of **Woodwardia magna** sp. nov.
8. Distal tip of genital seta of **Eiseniella intermedius** sp. nov.
9. Distal tip of penial seta of **Plutellus candidus** sp. nov.
10. Spermatheca of **Woodwardia magna** sp. nov.
11. Spermatheca of **Eiseniella intermedius** sp. nov.
12. Portion of base of penial seta of **Plutellus candidus** sp. nov.
13. Spermatheca of **Plutellus candidus** sp. nov.

PLATE XVI.

- Fig. 1. Longitudinal section through segments 12 and 13 of *Astacopsidrilus norus* f.s., funnel-structure; g.p., granular ellipsoid particles; int., gut; ov., ovary; pe., penis; sp.d., spermiducal gland.
2. Section through the apex of the funnel-structure of same (high power), showing gland cells and setae.
3. Penis of same with the sheath incompletely everted.
4. Transverse section of the dorsal vessel of *Eiseniella intermedius* in the region of the hearts.
5. Longitudinal section through the clitellum of *Kerria nichollsi*; c.m., circular muscle; l.m., longitudinal muscle; gl.c., glandular layer.
6. Longitudinal section through the gut of *Eiseniella intermedius* in segments 15-19; giz., gizzard; sep., septa.
7. Transverse section through segment 10 of same. d.v., dorsal vessel; g.s., sacs of the genital setae; gl.c., gland cells; ht., heart; int., gut; n.c., nerve cord; sep., septum.
8. Longitudinal section through segments 9-13 of *Kerria nichollsi*. c.f., ciliated funnel; ht., heart; int., gut; neph., nephridial tubes; oe.p., oesophageal pouch; o.f., oviducal funnel; ov., ovary; sp.s., sperm sacs; te., testes.
9. Longitudinal section through body-wall of segments 17-19 of same. sp.d., spermiducal gland.
10. Section through the penial bulb of *Enchytraeus albidus*. m.s., muscle strand; p.b., penial bulb; v.d., vas deferens.
11. View of the ventral surface of *Kerria nichollsi* (one side only, under high power) in segments 17-19. c.c., clitellar cells; g., groove; g.p., glandular papilla; m.v.l., Mid-ventral line; sp.p., pore of the spermiducal gland.

Plate XIV.

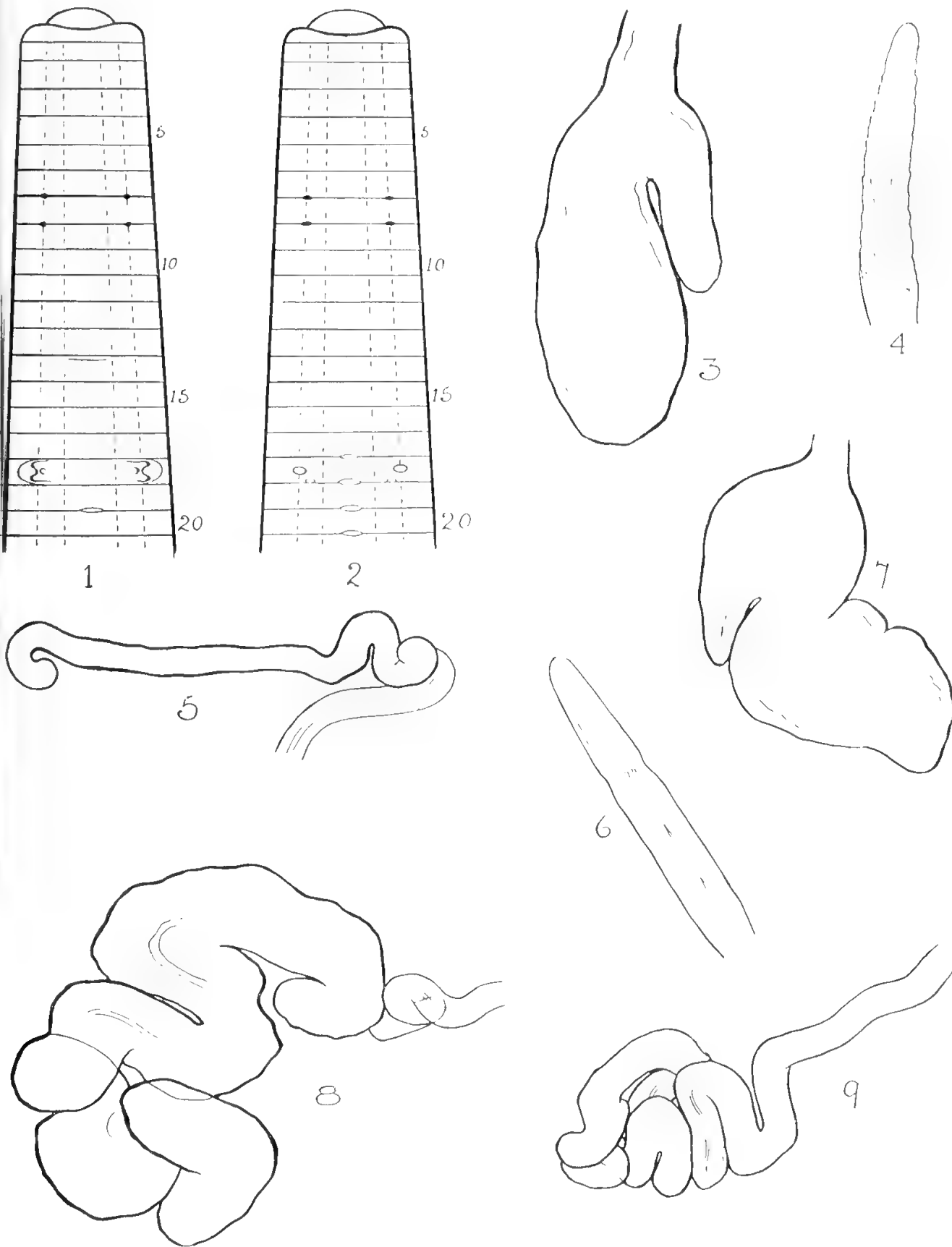


Plate XV.

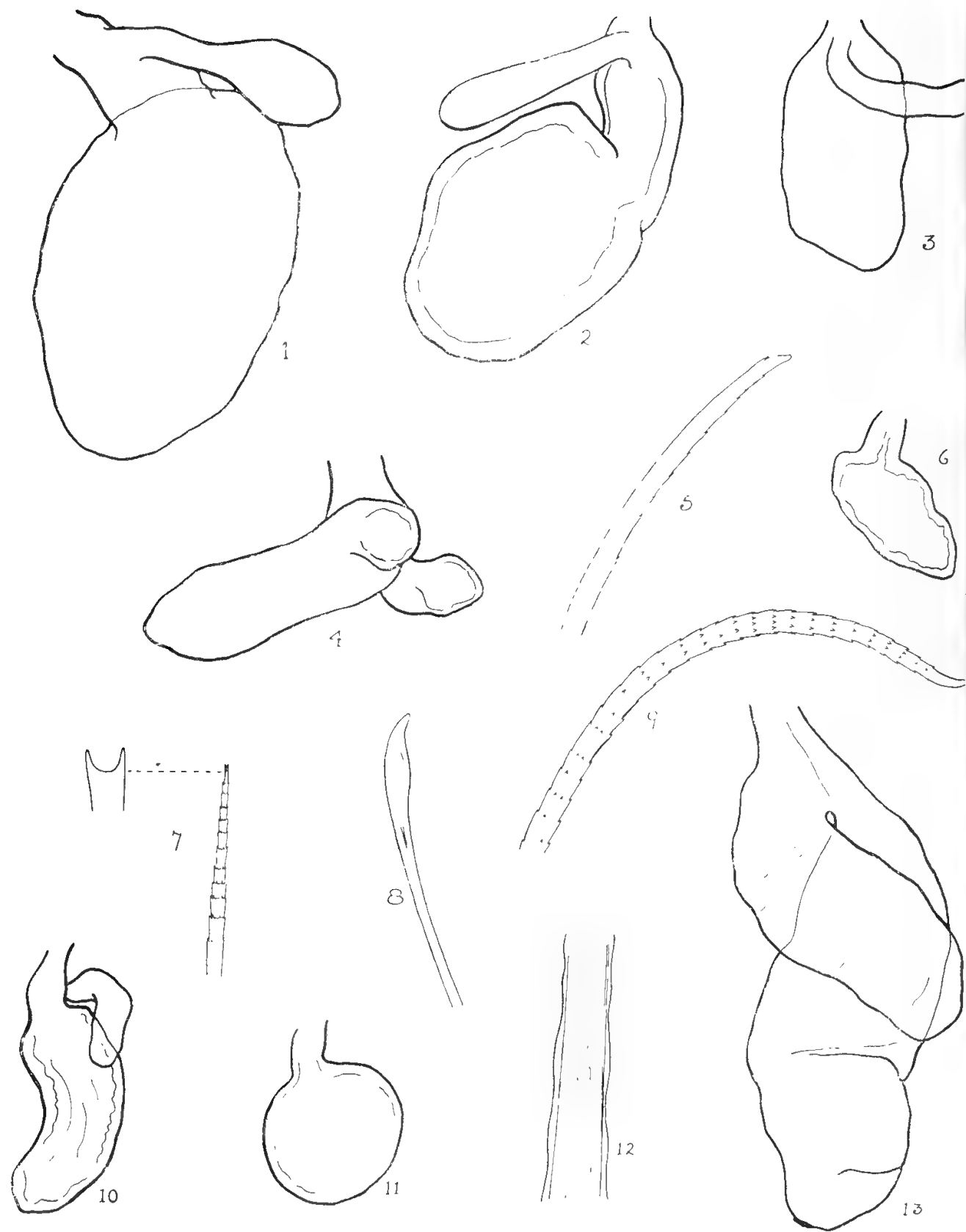
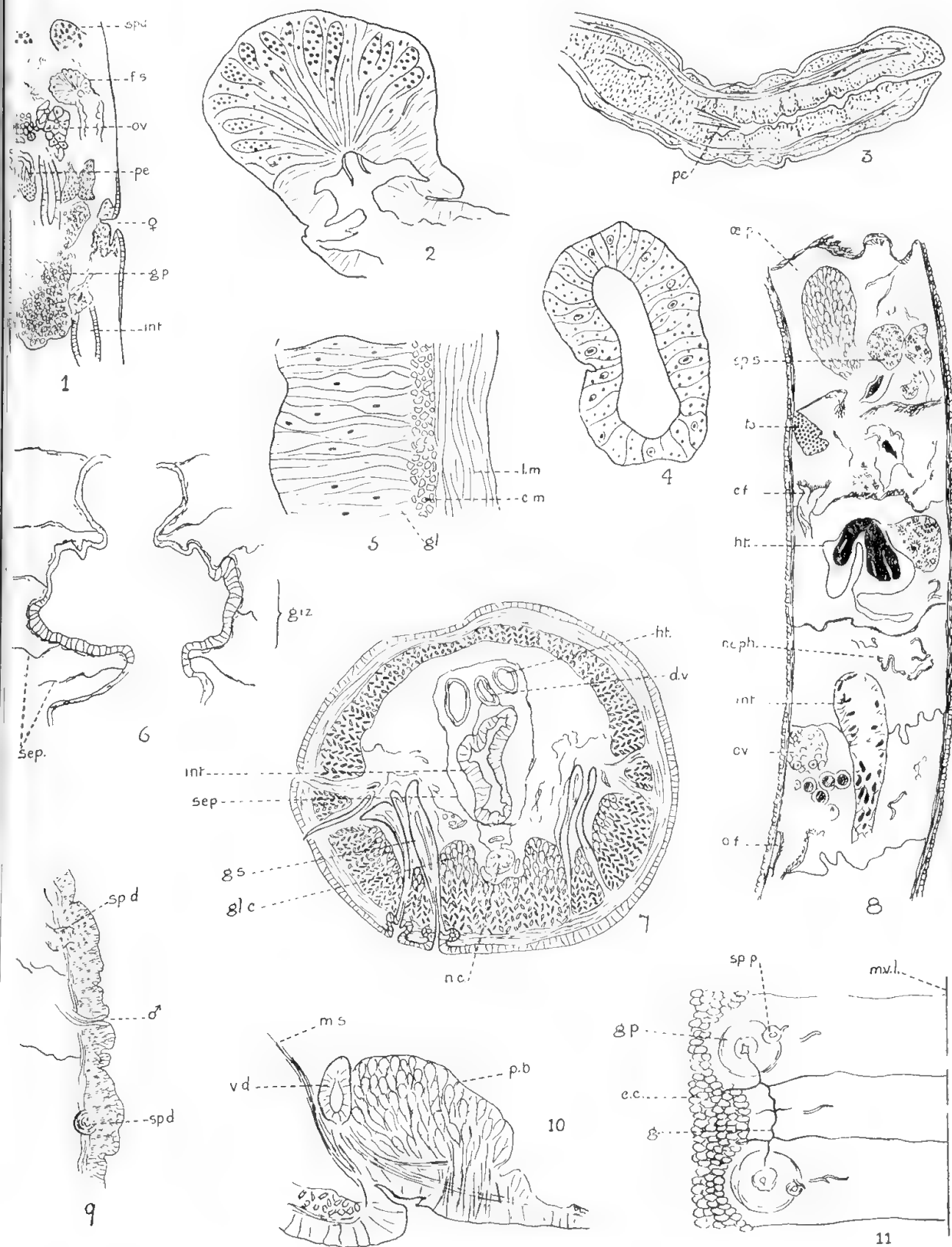
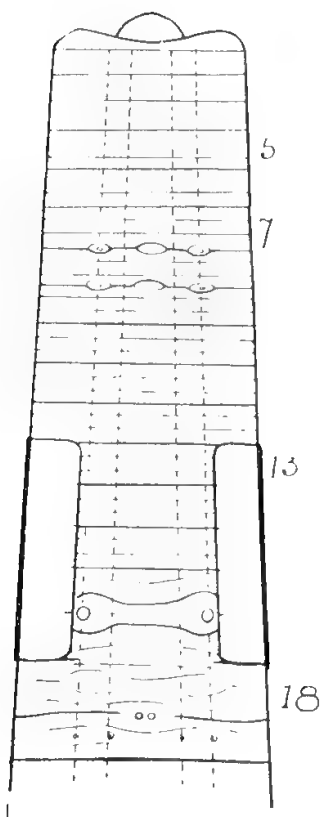
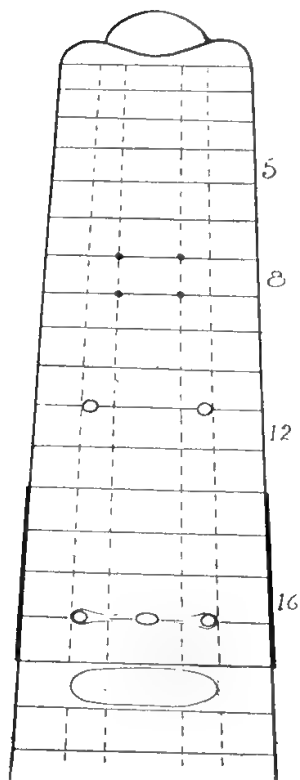


Plate XVI.

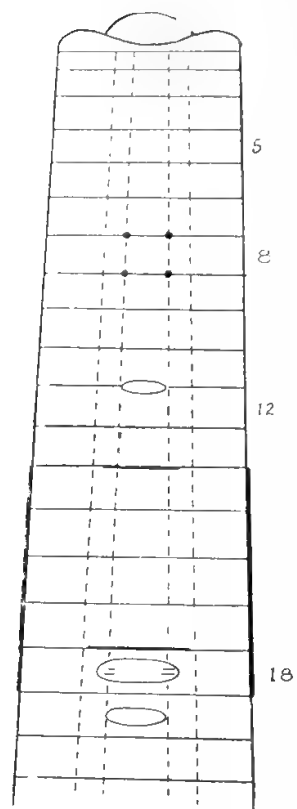




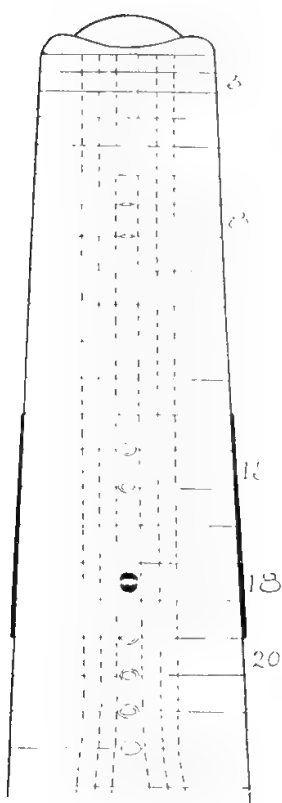
Text Fig. 6.
Plutellus candidus.



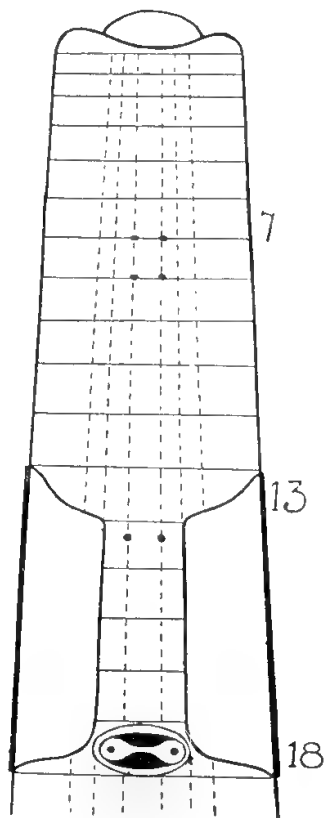
Text-Fig. 7.
Plutellus varicystis.



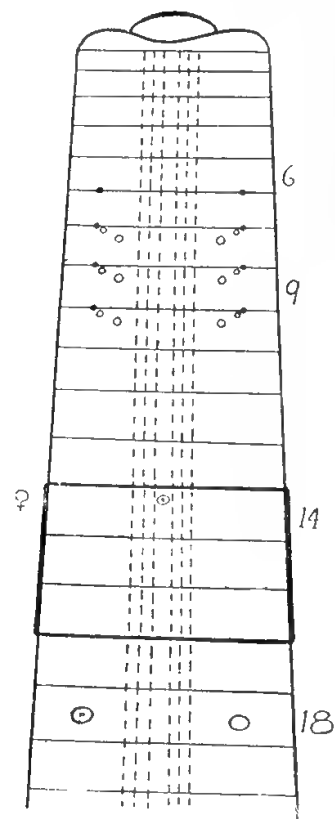
Text-Fig. 9.
Woodwardia magna.



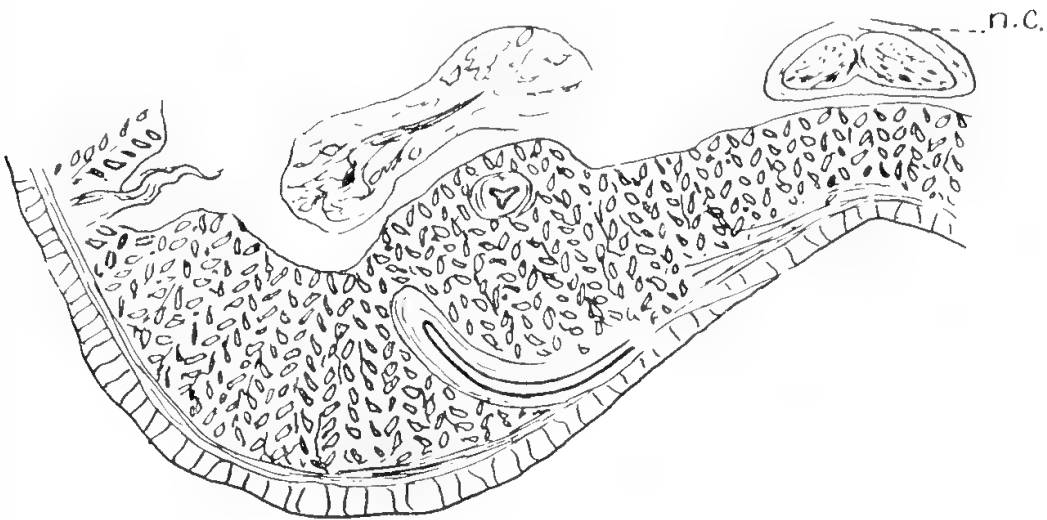
Text Fig. 10.
Megascorlex syndetoporus.



Text-Fig. 12.
Megascorlex albidus.

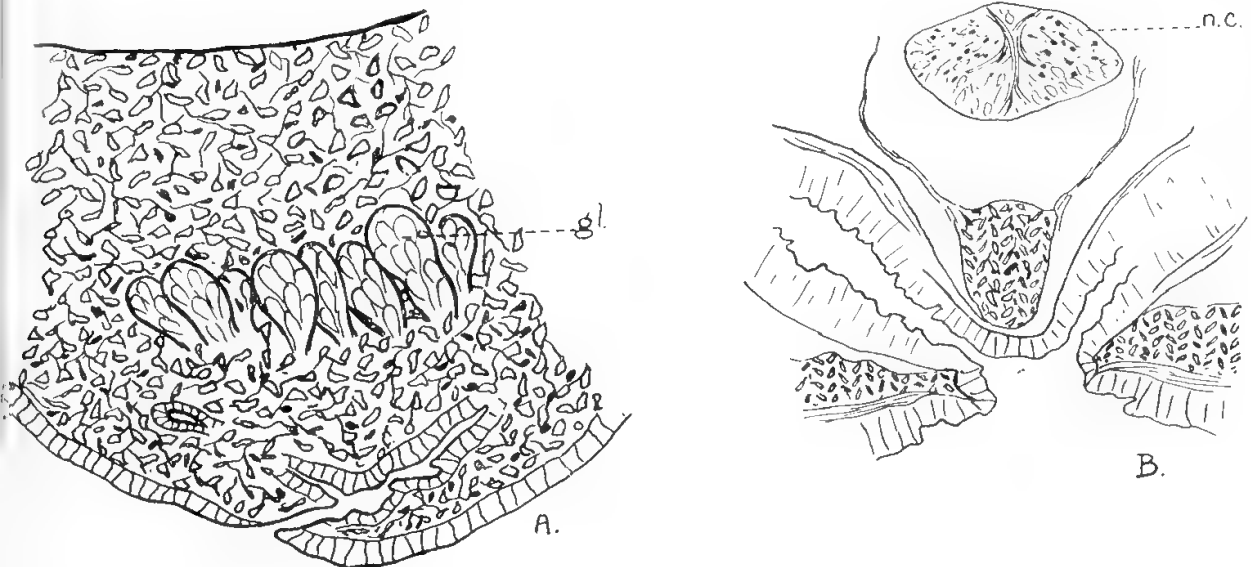


Text-Fig. 13.
Pheretima heterochaeta.



Text-Fig. 8.

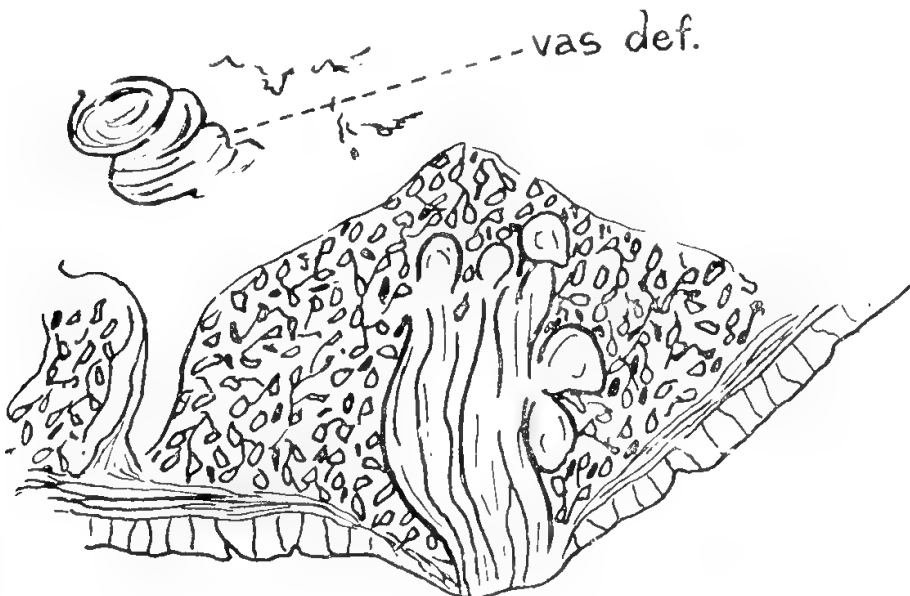
t.s. showing male efferent duct in the body-wall.



Text-Fig. 11.

Megascolex syndetoporus.

t.s. male pore. gl., glandular fascicles. B. t.s. spermathecal pores. n.c., nerve cord.



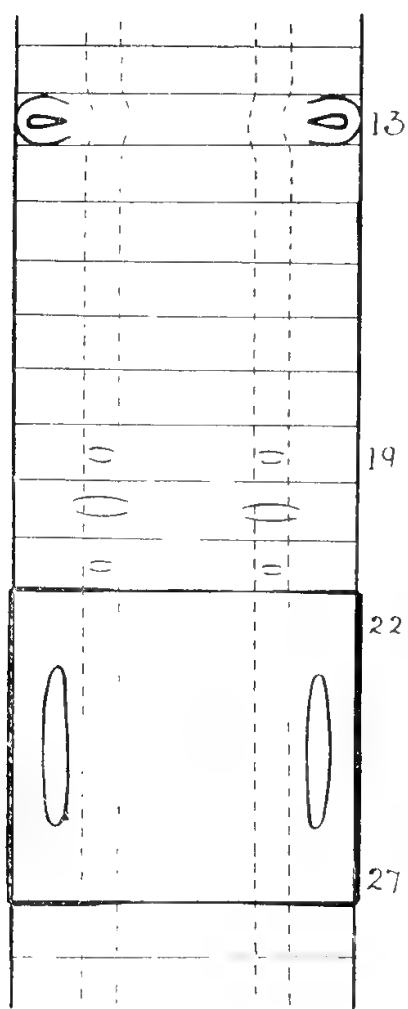
Text-Fig. 14.

Pheretima heterochaeta.

t.s. glandular papilla in segment 18.

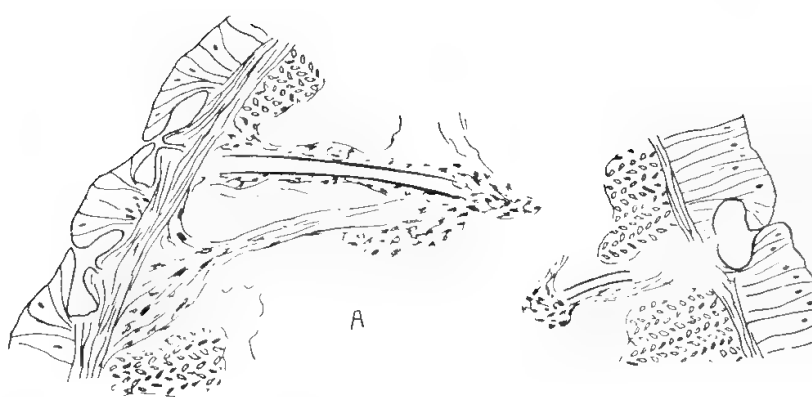


Text-Fig. 15.



Text-Fig. 16.

Eiseniella intermedius.



Text-Fig. 17.

Eisenia foetida.

A. Lateral setal sac from seg. 11. B. Ventral setal sac from clitellar region.

5.- CONTRIBUTIONS TO THE MINERALOGY OF WESTERN AUSTRALIA—SERIES VI.

By EDWARD S. SIMPSON, D.Sc., B.E., F.A.C.I.

Read 12th May, 1931; Published 25th June, 1931.

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(1) ALLANITE, WOODSTOCK, N.W. DIVISION.

In granite country on pastoral lease 5012 (part of Woodstock Station), at a point five miles S.S.E. of Trig. Station B4, several detrital specimens of allanite have been found on the outcrop of a pegmatite vein. The mineral is in black, glassy, sub-angular fragments, with a thin brown crust of weathering products, which also penetrate the mass in narrow veinlets. Occasional small scales of mica form inclusions in the masses or are attached to their surfaces. Thin sections under the microscope are transparent and isotropic, yellowish green in colour, with fine black inclusions, especially along a rectangular network of indistinct cleavages. Heated in a closed tube, the mineral gives off a little water, but does not change in colour, decrepitate or melt. Before the blowpipe thin edges melt and boil. The refractive index was determined by the immersion method to be 1.692 for the analysed powder in sodium light.

An analysis was made for me by Mr. D. G. Murray, A.A.C.I., with the following results:—

ALLANITE, WOODSTOCK.

SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	Ce ₂ O ₃	La ₂ O ₃	Di ₂ O ₃	(Y,Er) ₂ O ₃	ThO ₂	TiO ₂	
30.60	16.18	3.52	19.36	Nil	Nil	2.22	1.02	0.36	
FeO	MnO	CaO	MgO	(K,Na) ₂ O	H ₂ O —	H ₂ O +	Total.	G.	N.
8.60	4.48	7.76	.46	Nil	.22	5.07	99.85	3.52	1.692

A careful search for lanthanum and didymium failed to reveal any trace of those metals, repeated treatment of the freshly precipitated rare earth hydroxides with saturated solution of bromine yielding no soluble hydroxides whatever. In this respect the Woodstock allanite appears to be unique, all the newer analyses quoted by Doelter * showing oxides of these metals in quantities varying from 2.7 to 17.3 per cent.

* H.B. der Mineralchemie II. (2), 864-870.

The formula calculated from the analysis is :—



which is a hydrated modification of one of Nils Engstroms formulae, † viz. :



corresponding to the general formula for the Zoisite Group to which allanite belongs. Similar hydrated allanites are known from Norway and Sweden.

(2) ANDALUSITE AND SILLIMANITE, NINGHANBOUN HILLS, S.W. DIVISION.

The Ninghanboun Hills, which lie about 25 miles east of Morawa in Lat. 29° 12' S., and Long. 116° 27' E., form the north-western shore of Weelhamby Lake, and are about three miles long by one mile or less wide, and at most 200 feet high. They rise out of the granite plateau which has a level here of about 850 feet above sea. Although physiographically insignificant, they present an almost complete microcosm of the Archaean rocks of the State. The centre and northern slopes consist of greenstones of various kinds, both massive and schistose, with jasper bars, quartz veins and pegmatite veins, the southern slopes of highly metamorphosed sediments, with what are probably interbedded tuffs or lavas, and intersecting dykes of later age. The trend lines bear about 80° east of north.

SILLIMANITE.

In the low cliffs of Lake Weelhamby immediately south of the amphibolite, cummingtonite schist and serpentine, which form the eastern end of the greenstone series, a cross section of sillimanite schist is exposed for a width of several chains. The rock is greyish white in colour, distinctly schistose with slightly silky lustre, and in places dotted with a few red garnets. It is somewhat porous from the weathering and partial leaching of biotite, chlorite, and felspar. Under the microscope the rock is seen to be composed of coarsely granular quartz with dense bundles of sillimanite fibres lying parallel to the schistosity and often penetrating the quartz grains. An occasional garnet is visible, and some finely granular sericite with a weathered intergrowth of biotite and muscovite, and granular black and brown iron ore. Some of the sillimanite was separated by means of methylene iodide, and proved to possess the characteristic optical properties.

A few chains inland a much denser, and almost completely unweathered, sillimanite quartzite was collected. The microscope discloses a coarse mosaic of quartz on which are superimposed numerous bundles and isolated needles of colourless to light brown sillimanite ; these do not interrupt the structure of the quartz mass, but penetrate it in every direction. There is an appreciable parallelism of most of the bundles, but others are arranged in radiating groups, or set at various small angles to the direction of schistosity. Small flakes of brown biotite are present, and at rare intervals a granular aggregate of andalusite, showing a colourless to pink pleochroism.

About a mile and half further west a dense dark grey rock was found which showed small silky patches of white sillimanite on the faces of fractures. A section showed the rock to be a granular quartzite with plentiful sheaves and isolated fibres of sillimanite. A fair proportion of the sheaves show a broad and apparently structureless centre, with terminal

† Ibid, p. 874.

proliferation into fine spicules. Under high magnification and crossed nicols the centres of these masses prove to be finely fibrous. Scales of biotite are present, with an occasional scale of chlorite or crystal of garnet. Granular black iron ore is plentiful.

ANDALUSITE.

In addition to the small quantity of andalusite mentioned above as occurring in specimens of sillimanite schist, there are long narrow lenses of andalusite-muscovite schist interbedded in the sediments. One such occurs close to the east end of the range where the outcrop is covered by many loose boulders of the rock showing abundant andalusite individuals projecting from the scaly micaceous surface. The andalusite in these is sub-angular, the individuals averaging about one centimetre in length. They are subvitreous, of a dark brown colour, and show no signs of chiasmolite structure. One band in this mass is less plainly micaceous, and is grey in colour from the presence of finely divided carbon, with which the andalusite itself is saturated.

About two miles to the south-west another band of carbonaceous andalusite schist is exposed on the outermost slopes of the hills. This is very much weathered, and the andalusite weathers out in hard, dark grey carbonaceous lenses about one centimetre long.

In a creek between the two places mentioned, large angular pebbles of pure crystalline andalusite were found. These were traced to two highly quartzose pegmatite veins traversing hornblende schist near the crest of the ridge. The two veins were only a short distance apart and the portions of the outcrops in which andalusite was visible were only about a chain in length. In the outcrops andalusite was lying loose on the surface, or projecting from the quartz, in masses weighing from something under a kilogramme to 25 kilogrammes (50 lbs.). Masses over five kilos were quite common. They were slightly divergent groups of coarsely prismatic crystals, none of the latter being sufficiently clearly developed to afford angular measurements. They were mostly of a deep purple colour, but even in the one mass the colour often ranged from light vinaceous grey (Ridgway 69^f) to anthracene purple (69^k), the lighter portions forming vertical streaks in, or outer borders to, the large masses. The accompanying Plate XVII. shows typical specimens of the mineral. A similar occurrence is described by Calderon at Montalban, Toledo, Spain.*

One of the darker coloured pieces was selected for analysis and gave the following results:—

ANDALUSITE, NINGHANBOUN HILLS.

SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	Mn ₂ O ₃	Ti ₂ O ₃	H ₂ O +	Total.	G.	N.
36.06	60.80	1.61	trace	.11	.94	99.52	3.13	1.643, 1.638, 1.632

(Analyst: H. P. Rowledge.)

Examination of the powder revealed a straight extinction with normal optical sign and pleochroism, viz. :—X, magenta; Y, Z, colourless.

A special search was made for manganese in the mineral in view of its purple colour, but only a faint trace of that element could be detected. The colour appears therefore to be due to the iron and titanium.

* Calderon: Los Minerales de Espana, II., p. 321, Fig. 142.

(3) CUMMINGTONITE (KUPFFERITE), NINGHANBOUN HILLS, S.W. DIVISION.

Cummingtonite has been defined as a monoclinic amphibole midway in composition between kupfferite ($\text{H}_2\text{Mg}_7\text{Si}_8\text{O}_{24}$)* and grunerite ($\text{H}_2\text{Fe}_7\text{Si}_8\text{O}_{24}$). Strictly speaking, therefore, all cummingtonite is either a ferruginous variety of kupfferite or a magnesian variety of grunerite. Cummingtonite schist is an unusual type of metamorphic greenstone which has only been recorded from a comparatively few districts throughout the globe. The recent discovery by the writer of an outcrop of it in the Ninghanboun Hills appears, therefore, to be worthy of description.

At the eastern end of these hills it was found in the Archaean complex in a narrow belt lying between serpentine and amphibolite on the one side, and andalusite schist and sillimanite schist on the other. A continuous band, or more probably a series of lenses, of this rock extends for about two miles in a westerly direction parallel to the boundary of the greenstones and meta-sediments.

The rock is pale to medium grey on fresh fracture, and cream coloured, or sometimes reddish, on the slightly weathered surface. In specimens collected near the east end of the hills, innumerable spicules of colourless to pale grey cummingtonite are plainly visible on fractures or weathered surfaces. These are oriented in different directions within the planes of cleavage. A section shows a rather finely granular base of plagioclase, sometimes singly or multiply twinned, in which are set the prismatic crystals of the amphibole. Several crystals twins and grains of transparent orange rutile were observed in the section as well as a little black iron ore, probably chromite.

An analysis of the fresh rock showed:—

CUMMINGTONITE SCHIST, NINGHANBOUN.

SiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	K_2O
57.40	12.88	.93	8.02	.16	11.73	5.23	.24
Na_2O	TiO_2	Cr_2O_3	P_2O_5	$\text{H}_2\text{O} +$	$\text{H}_2\text{O} -$	Total.	G.
2.06	.45	.24	.11	1.42	.06	100.93	2.86

The analysis suggests a mixture of about 44 per cent. of labradorite with 55 per cent. of cummingtonite. In the latter lime is only present in traces whilst the ratio of Mg to Fe is 26 to 10. The Ninghanboun mineral is, therefore, a ferruginous kupfferite.

Some of the cummingtonite was separated with CH_2I_2 from the crushed rock, and its physical properties determined. The prisms are usually 0.5 to 2.0 mm. in length and 0.02 to 0.30 mm. in diameter. The specific gravity is 3.04, and the crystalline system is monoclinic, prisms in one

* Recent research indicates that the original kupfferite is a chromiferous actinolite, but the name has now come to connote the monoclinic lime-free amphibole. See A.J.S. 21 (1931, p. 343).

position showing a straight extinction, in others giving an angle with the vertical axis reaching a maximum of 17 degrees. The refractive indices determined by immersion were Ng 1.660 (at 17° with *c*), and Np 1.636 : Ng-Np, 0.024. The type mineral from Massachusetts is a magnesian grunerite in which the ratio of Mg : Fe is 10 : 19. The graph in Winchells Elements of Optical Mineralogy indicates the following data for typical cummingtonite with Mg : Fe = 1 : 1. G, 3.27 : N, 1.673, 1.659, 1.645 : Ng-Np, 0.028. Angle between Z and *c*, 14 to 20°. Sundius' graph in the American Journal of Science (Vol. 21, p. 338) indicates for the same compound, G, 3.28 : N, 1.676, 1.658, 1.647 : Ng-Np, 0.029.

(4) DRAVITE, DARLING RANGES, S.W. DIVISION.

Recent investigations by the Author in conjunction with Mr. J. E. Wells have indicated the probable wide distribution of dravite (magnesia tourmaline) in the western portion of the Darling Ranges to the east and south-east of Perth. The Ranges in this area consist of granite, criss-crossed by epidiorite dykes and fault planes, and enclosing narrow bands of mica schist, which may be shear zones of the granite or roof pendants of the Precambrian schists, as these appear in an almost continuous, narrow, belt along the western foothills of the range.

Dravite is especially plentiful at Swan View, moderately so at Karra-gullen, and occurs to an undetermined extent at Kelnscott and between Mundijong and Jarrahdale. In addition schorl has been detected in small quantities at Gosnells and Cardup.

SWAN VIEW.

About a mile and a half north of the railway station attention was attracted by the peculiar appearance of some of the local granite. Parts of it are covered on the weathered surface with innumerable grey "warts," and other parts, having a comparatively smooth surface, are dotted with distinctly blue or grey spots. Microscopic examination proves that both peculiarities are due to aggregations of minute spicules of dravite. The grey "warts" are mostly three to five mm. in diameter, and consist of a mass of minute radiating prisms which are colourless under the microscope, and possess all the characteristics of dravite. The blue or grey spotted granite has been found to have had all its components, except the quartz, almost completely replaced by a spicular dravite, varying from a colourless variety to one which is light blue in mass, but mostly colourless in thin section, or rarely possessing a pale dichroism, E colourless, O greyish blue. A radial grouping of the spicules is extremely common, the diameter of individual crystals varying from 0.01 to 0.06 mm. In some specimens of the rock the radial fibres are plainly visible to the unaided eye, in others they can be readily detected with a low power lens. But in some the structure is so finely fibrous and compact as to be obscure even under the microscope, except between crossed nicols. This tourmalinised granite is abundant over an area of about 0.2 hectare (half an acre). In this area some of the joints in the granite are filled with a dense mass of bluish grey dravite five to ten mm. thick, which under the microscope proves to be composed of a felted mass of needles, many of them in radial groups, and colourless to pale blue in the direction of O.

Further search of the locality has revealed at a short distance to the west a slightly porous vein, 30 cm. (12 inches) thick, of almost pure, pale grey dravite. Microscopic examination discloses the same interlocking radial groups of colourless spicules, associated with a little greatly weathered chlorite or biotite. Some of the pure mineral from this vein was separated by methylene iodide and analysed, with the results given below. It is a typical dravite in composition, and chemical and physical properties.

Less than a kilometre (say half a mile) further to the north-east a similar but larger vein was discovered in a narrow band of mica schist flanked by granite. This vein bears 55° , and is about 60 cm. (2ft.) wide. It is less porous than the first vein, and paler in colour, almost white in places, mottled with dull green chlorite, etc. Under the microscope it is seen to consist mainly of a similar mass of colourless dravite spicules, accompanied by patches of partly weathered biotite, chlorite, muscovite, kaolin, and limonite.

Mr. Wells has followed the strike of this vein and secured specimens of dravite at intervals for about another two kilometres (1.25 miles). Altogether in this area many tons of dravite must be exposed at the surface.

KARRAGULLEN.

Crossing Black Adder Creek and the Dale Road five miles south-east of Karragullen railway station are two parallel veins composed of a mixture of quartz and dravite, the latter in large excess over the former. The ground is much obscured by soil and lateritic gravel, but sufficient outcrops can be seen in the vicinity to show that the veins are in granite in close proximity to an epidiorite dyke. They strike approximately east. No continuous outcrop can be traced, but only a series of large masses of the vein-filling, projecting at intervals from the soil, and in one place from the bed of the creek. From the appearance of these the veins must be about a metre (3 feet) in width.

Material collected from the outcrops is of three types. (A) A mixture of white quartz and white dravite in which the latter is just visibly seen to be spicular in form, and frequently grouped in radiating masses. From such material pure dravite was separated by CH_2I_2 and analysed (see below). Under the microscope the mineral is seen to be in perfectly transparent colourless prisms, with straight extinction, high birefringence and negative elongation. Individual prisms range up to four mm. in length but are usually only 0.02 to 0.10 mm. in diameter.

(B) A second type looks like a finely granular white quartzite. Slices under the microscope reveal a dense intergrowth of small stout prisms of colourless dravite with a small percentage of quartz in the form of archipelagoes of interstitial fillings.

(C) Most plentiful is a dense pale grey mass of dravite with no structure in the main mass visible to the naked eye, but including veinlets and geodes of distinctly spicular nature. A slice of this dense rock reveals under the microscope a structure practically identical with B, the dravite being colourless and in the form of grains and prisms averaging 0.1 mm. in diameter, without any regular arrangement, either radial or parallel.

DRAVITE, DARLING RANGES.

—				Karragullen.	Swan View.	Jarrahdale.	Kelmscott.
SiO ₂	...	...	...	38.30	36.57	36.80	36.14
Al ₂ O ₃	...	...	...	36.99	35.01	37.14	29.98
Fe ₂ O ₃	...	...	...	trace	trace	.18	?
FeO	...	...	...	.22	1.12	1.80	10.50*
MnO	...	...	...	.01	.01	trace	trace
MgO	...	...	...	8.90	11.40	8.33	6.78
CaO	...	...	...	<i>Nil</i>	.37	.11	1.16
Na ₂ O	...	...	...	1.88	1.39	1.60	...
K ₂ O	...	...	...	<i>Nil</i>	.25	.08	...
Li ₂ O	...	...	...	.16	<i>Nil</i>	<i>Nil</i>	...
H ₂ O+	...	...	...	3.55	4.46	4.48	...
H ₂ O—	...	...	...	<i>Nil</i>	<i>Nil</i>	.10	...
TiO ₂	...	...	...	.15	.36	.18	.52
B ₂ O ₃	...	...	...	10.38	9.78	9.63	...
F	...	...	...	.07	n.d	n.d	...
				100.61	100.72	100.43	n.d
Analyst	...			Murray	Simpson	Rowledge	Grace
MgO : FeO	...	...	...	737 : 10	177 : 10	83 : 10	11 : 10
G	...	...	...	3.03	3.03	3.03	3.07
No	...	...	...	1.634	1.635	1.636	1.658
Ne	...	...	...	1.612	1.612	1.614	1.632

* Total iron expressed as FeO. The figures for the refractive indices, determined by the immersion method, illustrate the rise in these figures with increase of iron.

JARRAHDALÉ.

A number of specimens of dravite have been brought to me from an ill defined spot between Mundijong and Jarrahdale, which are five miles apart. They consist of a fairly dense and tough bluish grey rock, which on close inspection is found to be an agglomeration of spherical masses of radiating needles of dravite. The composition of the carefully purified mineral is shown in the table above. The spherical masses are mostly five mm. in diameter, whilst the fibres of which they are composed are 0.02 to 0.1 mm. in diameter and two to three mm. long. Under the microscope they are either colourless in both directions, or E is colourless, O pale blue. In hand specimens the centres of the radial masses are either white or almost so, the colour deepening in passing outwards through Ridgways gull grey to deep gull grey.

This occurrence has not been inspected by the Author, but it is probable that the mineral is in veins in granite or gneiss as at Swan View and Karragullen.

KELMSCOTT.

About 1913 the late A. J. Robertson, a member of the Author's staff, collected what is probably a unique specimen of dravite in the ranges near Kelmscott. Unfortunately the exact locality was not recorded at the time, and has not been rediscovered. This specimen represents a vein 4.5 cm. (1.75 in.) wide filled with what, but for its colour, would be taken for "cross fibre" asbestos. Analysis proves that the mineral, which completely fills the vein, is a ferruginous dravite (see partial analysis above). It is in long, very narrow (0.01 to 0.03 mm.) fibre extending inwards from either wall, and meeting at the centre line, where owing to dislocation of the walls, the axes of the fibres take an S form. The only associated mineral is quartz which occurs in thin discontinuous masses on the walls of the vein.

(5) GAHNITE, GREENBUSHES, S.W. DIVISION.

As long ago as 1907 the Writer recognised gahnite in alluvial tin ore from Greenbushes and recorded its occurrence in Geological Survey Bulletin 30. In Bulletin 32 (1908), H. P. Woodward published a table showing the results of a mineralogical investigation by the present Writer of a number of typical Greenbushes concentrates, all from alluvial ground. This shows the existence of gahnite as a minor constituent of dressed tin ore from Spring, Floyd's, Elliott's, and Battler Gullies, all arising in the high ground surrounding the town. In the Writer's experience it was most plentiful in Spring Gully, to the west of the town, where it was associated with kaolin, quartz, cassiterite, ilmenite, zircon, rutile, magnetite, garnet, kyanite, and limonite. An old Greenbushes tin miner says, however, it was still more abundant in Bunbury Gully and other places at the south end of the field.

The only record of its occurrence *in situ* is that by F. R. Feldtmann and R. A. Farquharson*, who observed it in lodestuff (albite pegmatite) in the Kapanga tin mine (M.L. 515), where it is associated with albite, quartz, schorl, cassiterite, and garnet.

In the concentrates examined, gahnite occurs either in rounded grains, or in well defined octahedra. No crystal faces other than those of the unit octahedron have been observed. In size the individuals range from 0.5 to 5.0 mm., and in colour from almost colourless through various shades of green to greenish black. The usual size is about two mm., and the commonest colour celadine green (R33^b). Under the microscope the mineral is translucent to transparent, and isotropic. The refractive index, determined for me by Mr. H. Bowley by immersion in matured mixtures of piperine and iodides, is $1.818 \pm .005$. Its specific gravity varies from 4.55 to 4.58.

An analysis was recently made of a carefully selected parcel of grains of uniform celadine green colour. The results are: -

GAHNITE, GREENBUSHES.

	Al ₂ O ₃	Fe ₂ O ₃	(r ₂ O ₃)	FeO	MnO	ZnO	MgO	CaO	SiO ₂	Total	G.	N.
Per cent.	53.73	2.53	Nil	1.72	.50	41.66	Nil		.70	100.83	4.57	1.818
Mols	527	16	—	24	7	512	—		12			

(6) GEDRITE, BULLSBROOK, S.W. DIVISION.

Gedrite is an uncommon aluminous variety of anthophyllite, not previously recorded in the State. Normal anthophyllite has the composition:



Gedrite is a co-crystallisation of one or more aluminous molecules with the above, possibly -



In both varieties ferrous iron usually displaces part of the magnesia.

The Bullsbrook mineral occurs in the Archaean complex in a coarse gabbro pegmatite composed of gedrite and an undetermined plagioclase with

* G.S.W.A., Bull. 59, pp. 166, 169.

a little microscopic rutile. It is in long "deep slate green" (R33k) prisms up to several centimetres in length and one in width. There is a marked prismatic cleavage with a prism angle of approximately 60° . The specific gravity is 3.16, and the refractive indices are 1.659, 1.653, 1.643. Ng-Np, 0.016.

The extinction is straight in the prism zone and elongation positive. Considering the deep colour of the mineral in mass it was strange to find that under the microscope the powder is almost colourless; even in fragments 0.1 mm. thick the absorption is slight, the pleochroism being colourless to pale smoke brown or greenish brown, with the maximum absorption parallel to Z. This absorption, however, is much more pronounced when the thickness reaches 0.3 mm., at which the pleochroism is pale greenish yellow to greenish brown.

Material for analysis was obtained by separation with methylene iodide, and was checked for homogeneity with the microscope. The original analysis yielded 2.96 per cent. of TiO_2 , but separation with HF plus H_2SO_4 and microscopical examination, showed that this was present as crystallised rutile. The composition, which is very close to that of the type mineral from Gèdres in France, is:—

GEDRITE, BULLSBROOK AND GEDRES.

—	SiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO
Bullsb Brook...	45.38	14.70	.94	18.14	.31	15.26	.62
Gèdres ...	42.86	16.52	...	18.82	...	15.51	1.90

—	Na_2O	K_2O	H_2O —	H_2O +	Total.	G.	N.
Bullsb Brook...	1.20	.19	.23	2.77	99.74	3.16	1.659, 1.653, 1.643
Gèdres ...	...	...	...	4.50	100.11	...	(E.S.S.)

Analyst: D. G. Murray.

The Bullsb Brook mineral represents a cocrystallisation of the following molecules:—

Anthophyllite	...	$\text{H}_2(\text{Mg}, \text{Fe})_7\text{Si}_8\text{O}_{24}$	...	69.0 pe. cent.
(Unnamed)	...	$\text{H}_2\text{Mg}_4\text{Al}_6\text{Si}_5\text{O}_{24}$	...	20.5 "
Glaucophane	...	$\text{H}_2\text{Na}_2\text{Mg}_3\text{Al}_2\text{Si}_8\text{O}_{24}$	...	10.5 "

(7) LECHATÉLIERITE, WEST POPANYINNING, S.W. DIVISION.

Lechatelierite is the name given by A. Lacroix in 1915* to naturally occurring silica glass, his original paper describing its occurrence in quartzose xenoliths in lavas, and in fulgurites, the latter found both in loose sand and in acid rocks such as granite and siliceous schists. A third mode of occurrence has been described by A. F. Rogers † in the sandstones surrounding the meteor crater near Canyon Diablo, Arizona, where it is supposed to have formed as the result of the high temperature following the impact of an immense meteor on hard sandstone.

Fulgurites, the fused tubes formed by lightning when an exceptionally powerful current strikes dry sand or soil, are composed mainly of lechatelierite.

* Bull. Soc. Franc. Min. 38, pp. 182, 188.

† Am. Miner. 13, pp. 77, 82.

ierite, and are known to be present amongst the sand dunes near Sydney, not to mention many foreign localities. Up till now they have remained undiscovered in Western Australia.

On 6th April, 1931, Mr. G. E. Watts, of West Popanyinning, had the good fortune to observe the formation of a fulgurite. During the course of a severe thunderstorm he saw a violent flash of lightning strike some sandy ground about 400 yards away, and thereafter smoke or steam rising from the ground where it was struck. On investigation he found the ground blackened and still hot over an area about 20 cm. (8 inches) in diameter, and digging revealed a vertical core of lechatelierite in the soil. This core was hollow and very brittle, and extended downwards for about a metre (approximately 3 feet), small branches radiating from it at several points.

Through the courtesy of the Government Astronomer (Mr. H. B. Curlew) and the Curator of the Museum (Mr. L. Glauert) I have been enabled to examine in detail a number of short sections of the fulgurite. The soil in which it was formed is a cream or buff coloured, somewhat clayey and felspathic sand. The cross section of the central hollow is very variable, in places almost round, in others lenticular or angular, with wing-like extensions throughout, which give rise to a two, three, or four rayed section, narrow hollows extending practically to the ends of the rays. This hollow structure appears to be due to the expansion of steam at the time of formation. The form at various depths is illustrated in Plate XVII., Fig. 2.

The thickness of the fused lining is mostly 0.5 to 1 mm. and nowhere exceeds 2 mm. On the outer surface it is dull and rough from adherent sand and clay, but the inner surface is brilliant and glassy with a minutely mammilated structure. In colour this surface is greyish white and translucent, but small areas are darkened by the presence of iron silicate, etc.

Some of the cleanest fragments were lightly crushed to pass a 60-mesh sieve, and vanned to remove fine clay particles. After drying, the remainder was separated into several fractions by means of methylene iodide mixed with xylol. The fraction having a specific gravity between 2.20 and 2.22, was proved by the microscope to be pure lechatelierite. It was almost wholly colourless, the few darker grains proving to owe their appearance to plentiful inclusions of gas bubbles from which much of the material was entirely free.

Optical examination proved the separated mineral to be isotropic. Its refractive index was determined by immersion in a mixture of alboline and kerosene. In a mixture having a R.I. of 1.465 some of the grains were found to have an identical index, about one-third of them had an index slightly higher, and an equal number were slightly lower than the medium. *N* may, therefore, be taken at 1.463 to 1.467, figures slightly higher than that given by A. Lacroix for the natural mineral of high purity, viz., 1.4585. The density too is slightly greater than that of pure fused silica which is 2.205.

Analysis explains this increased refraction and weight, the Popanyinning glass containing a considerable proportion of metallic oxides which must also materially lower the melting point below that of pure silica. The figures obtained were:—

LECHATELIERITE, WEST POPANYINNING.

SiO ₂	TiO ₂	Al ₂ O ₃	Fe ₂ O ₃	MnO	MgO	CaO	Na ₂ O	K ₂ O	Total.	G.	N.
88.46	.46	6.69	1.16	trace	.17	.17	.01	2.68	99.80	2.21	1.465

(8) PYROLUSITE, COPPERMINE CREEK, S.W. DIVISION.

A little desultory mining has been done for many years past on a number of manganese lodes running approximately east and west across the valley of Coppermine Creek to the east of the Fitzgerald River. The lodes occur in a complex of greenstones and schists of Precambrian Age. Most of the ore discovered has been a dense structureless, or slightly cellular, mixture of pyrolusite and psilomelane with more or less limonite. Small patches of highly crystalline ore were, however, met with, and one such has been subjected to detailed examination. This ore appears to have grown from the sides of cavities in a mamillary layer, or series of layers, each composed of bundles of imperfectly developed prismatic crystals at right angles to the surface of the cavity. The colour is black, lustre brilliant, specific gravity 4.58 and hardness 2. The composition of carefully handpicked material was:—

PYROLUSITE, COPPERMINE CREEK.

MnO ₂	MnO	NiO	Co ₂ O ₃	Al ₂ O ₃	Fe ₂ O ₃	BaO	CaO	MgO	CuO
92.52	2.33	.07	.65	.25	.15	.13	.02	.17	.12
PbO	Na ₂ O	K ₂ O	H ₂ O +	H ₂ O —	TiO ₂	CO ₂	SiO ₂	SO ₃	Total.
<i>Nil</i>	.06	.06	1.59	.64	<i>Nil</i>		.66	.02	99.44
									4.58

(Analyst: H. P. Rowledge.)

The data indicate that the crystalline mineral is a pseudomorph after manganite, composed mainly of pyrolusite, but intimately mixed with a little residual manganite and secondary psilomelane.

(9) STILBITE, GOOSEBERRY HILL, S.W. DIVISION.

Half-way up the railway zigzag on the face of Gooseberry Hill, is the large quarry from which the Perth City Council draws its supplies of epidiorite and granite for ballasting roads and making concrete. On the south-east side of the quarry the eastern wall of an epidiorite dyke is covered by a thin sheet of chloritic material in which from time to time lenses of stilbite have been found. These have a thickness of 0.5 (or even less) to 2.5 centimetres, with a vertical and lateral extension ranging from a few centimetres to about one metre. The lenses consist wholly of stilbite, or of a coarse grained mixture of stilbite and calcite.

The stilbite is always coarsely crystalline and occurs in tabular groups with fan-like structures, the perfect cleavage parallel to $b(010)$ being distinctly visible. Occasional small vughs permit of the free growth and recognition of crystal faces, the usual combination being bcm , combined in the form of a double twin by reflection and rotation on $c(001)$. This is a common structure illustrated in the text-books.

The colour is a pinkish buff, ranging from Ridgway "13f" to "15d." It is translucent in layers of one to two mm. The specific gravity is 2.17.

An analysis made for me by Mr. J. N. A. Grace yielded the following figures, after deducting 0·64 per cent. of CaCO₃.

STILBITE, GOOSEBERRY HILL.

				Per cent.	Mols.	87 A + 13 B.
SiO ₂	...	...	...	57·38	955	59·0 %
Al ₂ O ₃	...	...	...	15·37	154	15·1
Fe ₂ O ₃	...	...	...	·15	1	...
CaO	...	...	...	7·46	133	7·8
MgO	...	...	...	·21	5	...
FeO,MnO	...	...	...	<i>Nil</i>	...	...
K ₂ O	...	...	...	·18	2	...
Na ₂ O	...	...	...	·56	9	·6
H ₂ O+	...	...	...	16·67	926	} 17·3
H ₂ O -	...	...	...	2·02	112	
P ₂ O ₅	...	...	...	·04	...	...
TiO ₂	...	...	...	<i>Nil</i>	...	...
				100·34	...	100·0
G	...	...	...	2·17		

The composition of a co-crystallisation of 87 per cent. of CaAl₂Si₆O₁₆·6H₂O with 13 per cent. of NaAlSi₇O₁₆·6H₂O is given in column (3) for comparison.

DESCRIPTION OF PLATE XVII.

- Fig. 1. Large masses of crystallised Andalusite, weighing four to 20 kilos., photographed on outcrop, Ninghanboun Hills. (Scale, one-tenth.)
- Fig. 2. -Lechatelierite (Fulgurite), West Popanyinning. A and B show wing-like extensions of the main tube, an oblique section of which appears on the left side of each specimen, from which all loose soil has been removed ; C, a lenticular section ; D, an approximately circular section from close to the surface ; E, F, and G show the fulgurite *in situ* in the compact soil, E at a considerable depth. (Natural size.)

Plate XVII.



Fig. 1.

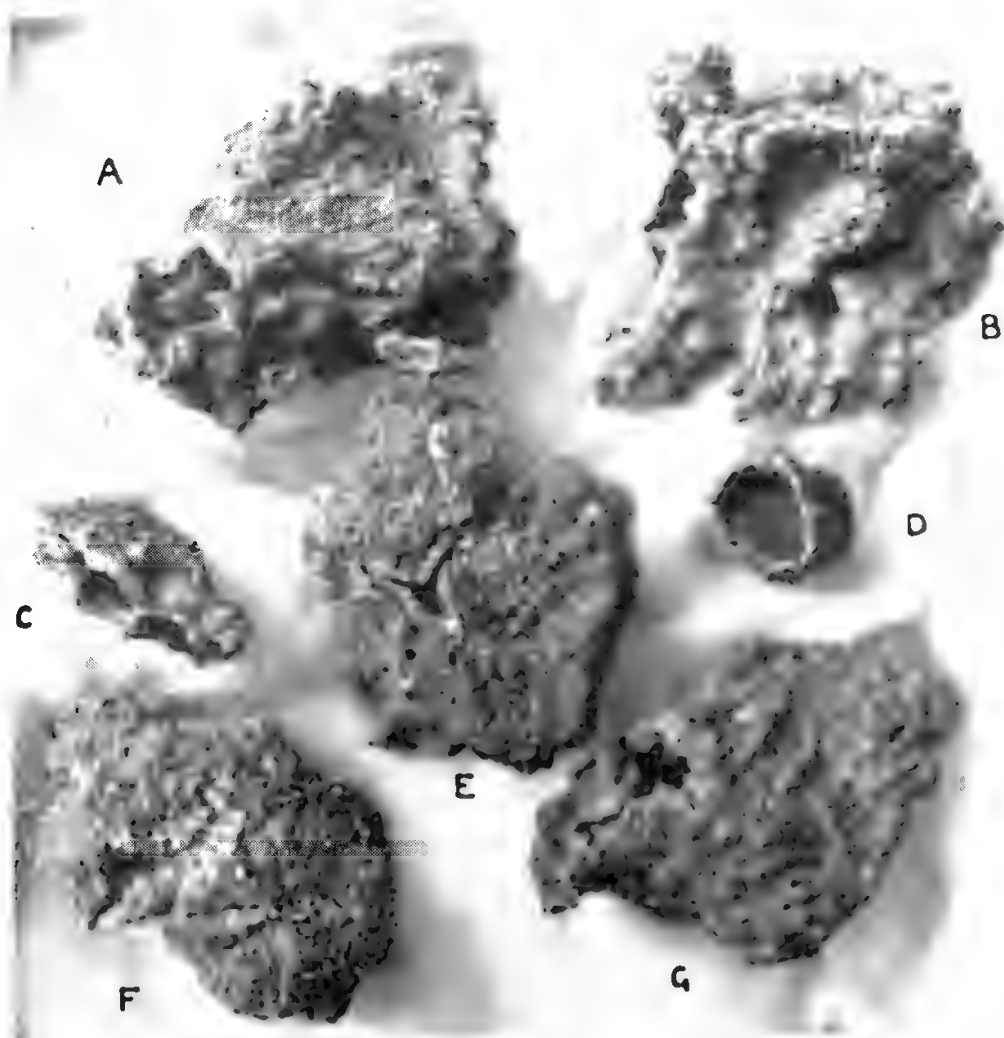


Fig. 2.

6.—THE OCCURRENCE OF RUBIDIUM, CAESIUM AND THALLIUM IN SOME WESTERN AUSTRALIAN MICAS.

By D. G. MURRAY, A.A.C.I., and F. E. CHAPMAN, A.A.C.I.

Read 12th May, 1931; Published 25th June, 1931.

The metals, caesium and rubidium are classed as the rarer alkali metals and are commonly found associated with the more familiar elements sodium and potassium in certain members of the mica group of minerals. Lepidolite mica which also contains considerable amounts of another alkali metal, lithium, is the main known rubidium bearing mineral, containing from traces up to 3 per cent. of rubidium oxide, and from traces up to 1 per cent. of caesium oxide also. Thallium also occurs in very small quantities in certain micas

Lepidolite has been found in a large number of places in Western Australia, and as its suitability as a prospective source of caesium and rubidium would depend on the quantity of these metals present the determination of these constituents is one of economic as well as scientific importance. As the occurrence of these three metals had not previously been recorded in any Western Australian micas, spectroscopic examinations of three samples of mica from different localities in the State were carried out by one of us (F.E.C.) in order to establish their presence or otherwise. The result of his work was to definitely establish the presence of all three elements in two of the minerals examined. It might be mentioned in passing that caesium had also been detected spectroscopically by the same worker in the rare caesium bearing variety of beryl, roosterite, found in a lithium bearing pegmatite at Wodgina, Western Australia. In the preparation of the samples for spectroscopic examination chemical methods were employed to separate as far as possible the caesium, rubidium and thallium from the other constituents of the micas. For the detection of caesium and rubidium a solution of what was assumed to be the chlorides of these metals was obtained and examined by the visual spectroscope. The thallium was separated as sulphide and this precipitate tested in a similar manner.

The results were:—

Mica.	Quantity taken.	Rubidium.	Caesium.	Thallium.
Lepidolite mica, Tappa Tappa	1 gm.	Present	Present	Present
Lepidolite, Londonderry ...	1 gm.	Present	Present	Present
Lepidolite, Widgiemooltha District	1 gm.	Absent	Absent	Present

A permanent spectrogram record of the presence of rubidium, caesium and thallium in the mica from Londonderry was also obtained by means of a quartz spectrograph, pure salts of rubidium and caesium being used to make standard exposures with for confirming the lines obtained from the mica.

An attempt was then made to roughly estimate the quantity of rubidium and caesium present in standard solutions of varying strengths by comparing the intensity of the lines. This method was found to be unsatisfactory, due to the limited range of intensities of rubidium lines and the error due to eye fatigue. A detailed description of the methods is given in a later paragraph.

The presence of the three elements having been established in two micas by means of the spectroscope, quantitative analyses were made of a number of micas from various parts of the State in order to determine if possible the actual quantities of these constituents present. The chemical characteristics of caesium and rubidium are very similar to those of potassium, and failure to separate them during the course of the determination of the alkali metals would result in a serious error in the potash figure.

Detailed descriptions and analyses* of several of the micas selected for the determination of caesium, rubidium and thallium have already been published, but no attempt had been previously made to determine the percentage of these constituents present. The results obtained were:—

—			Lepidolite Londonderry (Uniaxial).	Lepidolite Londonderry (Biaxial).	Lepidolite Poona.	Lepidolite Ubini.
			%	%	%	%
Li ₂ O	...	...	5·89	5·56	4·92	4·00
Na ₂ O	...	...	·84	·62	·86	·36
K ₂ O	...	...	10·03	10·10	9·24	10·55
Rb ₂ O	...	...	1·41	2·02	1·72	1·10
Cs ₂ O	...	...	trace†	trace	trace	trace
Tl ...	...	...	trace	trace	trace	trace

—			Lepidolite Tabba.	Lepidolite Ravensthorpe.	Lepidolite Wodgina.	Zinnwaldite Ubini.
			%	%	%	%
Li ₂ O	...	...	3·24	3·32	3·18	1·13
Na ₂ O	...	...	·92	·46	·56	·19
K ₂ O	...	...	10·34	9·52	9·64	9·76
Rb ₂ O	...	...	1·12	2·34	1·46	·46
Cs ₂ O	...	...	·25	trace	trace	trace
Tl ...	...	...	trace	trace	trace	trace

* Journal of the Royal Society, W.A., Vol. 13; Journal Natural History and Science Society, W.A., Vol. 4.

† Under 0.05 per cent.

The following alkali determinations in some micas from other parts of the world are given for comparison with the above.

		Lepidolite Nagaton Japan.	Lepidolite Maine, U.S.A.	Lepidolite Maine, U.S.A.	Zinnwal- dite Tanokami Japan.	Lepidolite Nubeb, S.W. Africa.
		%	%	%	%	%
Li ₂ O	... ..	2.49	4.34	3.87	4.24	4.93
Na ₂ O	... ..	3.20	2.17	.13	5.00	2.15
K ₂ O	... ..	9.13	8.03	8.82	7.89	9.26
Rb ₂ O	... ..	.96	2.44	3.73	.81	1.73
Cs ₂ O	... ..	...	.72	.08	...	.60

METHODS OF ANALYSIS.

The following method of analysis was employed for the determination of the metals of the alkali group.

Using the Lawrence Smith method for alkalis a weight of total mixed chlorides of the alkali group was obtained. The weighed chlorides were treated with a mixture of absolute alcohol and concentrated hydrochloric acid which gave a precipitate of sodium and potassium chlorides and a solution containing lithium, rubidium and caesium. The solution was evaporated to dryness on the water bath and retreated with the alcohol hydrochloric mixture. Any further precipitate of sodium and potassium chloride was added to the main precipitate, the whole dissolved in water and evaporated to dryness with a drop or two of hydrochloric acid, gently ignited and weighed as the mixed chlorides of sodium and potassium. The potassium was separated and weighed in the usual manner as chloroplatinate.

The filtrate containing the lithium, rubidium and caesium was evaporated to dryness and the mixed chlorides gently ignited and weighed. The chlorides were dissolved in water and the rubidium and caesium separated and weighed as chloroplatinates. This precipitate was dissolved in hot water containing a few drops of hydrochloric acid and the solution saturated with H₂S. The platinum sulphide was filtered off, the filtrate containing the rubidium and caesium evaporated to dryness and the chlorides of rubidium and caesium ignited and weighed. This weight was deducted from the weight of mixed rubidium, caesium and lithium chlorides to obtain the weight of lithium chloride. The rubidium and caesium chlorides were taken up in a minimum amount of concentrated hydrochloric acid, and a few drops of a saturated solution of antimony trichloride added to precipitate the caesium as a double chloride of antimony and caesium. The precipitate, if any, was washed with a mixture of hydrochloric acid and antimony trichloride solution and dissolved in 5N hydrochloric acid. The antimony was eliminated as sulphide and the filtrate evaporated to dryness, giving caesium chloride. The weight of caesium chloride was deducted from mixed chlorides of rubidium and caesium to obtain the amount of rubidium chloride. If no caesium was found on the addition of antimony trichloride, the percentage of rubidium present was calculated from the weight of rubidium chloroplatinate. A distinct precipitate was obtained with antimony trichloride when caesium was present in an amount equal to .0003 gm. Cs₂O.

METHOD FOR THALLIUM.

Two grammes of mica were heated with sulphuric and hydrofluoric acid and fumed till all HF was removed. After diluting with water the solution was partly neutralised with sodium carbonate, and the thallium reduced to the thalious state with sodium sulphite. Sodium carbonate was then added in excess and after warming for some time the precipitate, consisting mainly of aluminium hydroxide, was filtered off and washed. To the filtrate ammonium sulphide was added to precipitate the thallium. In each sample tested a very small black precipitate was formed. This was tested for thallium by dissolving in dilute sulphuric acid, and after boiling off H_2S , nearly neutralising with sodium carbonate. The cold solution was saturated with sulphur dioxide and treated with potassium iodide. If thallium be present in appreciable amounts a yellow precipitate of thallium iodide should be obtained. No precipitate of thallium iodide was obtained from any of the micas examined, but on testing the solution the characteristic thallium line was observed by means of the spectroscope.

In only one case, the biaxial lepidolite from Tabba, was a weighable amount of caesium recovered, but in all the other micas tested, although no precipitation took place on the addition of antimony trichloride, caesium could be detected spectroscopically in the solution.

Details of the methods employed in the spectroscopic examination of the micas were as follows:—

For the qualitative detection of rubidium and caesium by the spectroscope.

The alkali chlorides were prepared by the Lawrence Smith method from 0.5 gram mica. The dry chlorides were extracted with a few drops of conc. hydrochloric acid and 90 per cent. alcohol. This dissolved most of the rare alkalis along with sodium and potassium chloride. The solution was evaporated to dryness and the lithium removed from the dry residue by two extractions with a mixture of 5 ccs. absolute alcohol and 5 ccs. anhydrous ether, and decanted through a filter wet with ether alcohol mixture. The decantations were continued until a spectroscopic examination of the filtrate showed it to be lithium free. The filter paper was allowed to dry and the residue washed into the dish containing the alkali chlorides and the contents evaporated to dryness, dissolved in a small portion of water and chloroplatinic acid added. The precipitated rubidium, caesium and potassium chloroplatinates were filtered and washed repeatedly with hot water to remove the more soluble potassium chloroplatinate. Rubidium and caesium chloroplatinates were revealed by spectroscopic examination of the wash water from the mixed chloroplatinates. The minimum quantity of hot water should be used at this operation. The rubidium and caesium chloroplatinates remaining after washing with hot water were washed by decantation into a platinum boat and the double salts decomposed by gentle heating in a stream of dry hydrogen. The rubidium and caesium chloroplatinates were thus reconverted into their respective chlorides and platinum deposited. The mixed chlorides in the boat were dissolved in two drops of water and the solution examined with the spectroscope.

It was found necessary to remain in the dark room about twenty minutes before making observations with the spectroscope. A non-luminous flame about $\frac{1}{2}$ inch long from a small burner was found most satisfactory for the

production of the spectrum. The lines observed were—for rubidium two lines in the violet of wave length 4215·6 and 4201·8, and for caesium two lines in the violet end of the spectrum of wave length 4593·2 and 4555·3. To obtain a permanent record of rubidium and caesium in the mica from Londonderry by means of a spectrogram two grams of mica were taken and treated in exactly the same way as for the preparation of the chlorides of rubidium and caesium for visual spectroscopic observations. The carbon arc was used for exciting the spectra. The carbon rods used for the arc were first found to be free from rubidium and caesium. Before placing the rubidium and caesium chlorides on the carbon arc the spectrograph was adjusted and the plate placed into position. The poles of the carbon arc were then moistened with the solution of rubidium and caesium chlorides obtained from the mica and the exposure made. On the same plate exposures were made, using pure salts of rubidium and caesium chlorides, and their lines so recorded served as standard lines for reference. Lines for rubidium and caesium obtained from the alkalis and from the mica coincided with those from the pure salts. This confirmed the presence of rubidium and caesium in the biaxial mica from Londonderry.

The following method was adopted for the detection of thallium by the spectroscope.

One gram of mica was decomposed with conc. sulphuric and hydrofluoric acids, evaporated nearly to dryness and the mass taken up with about 5 ccs. of water, filtered, and the filtrate just neutralised with sodium carbonate. The filtrate was made up to 50 ccs. and saturated with hydrogen sulphide, allowed to stand overnight and decanted as much as possible through a filter from the brownish black precipitate which might contain thallous sulphide. A trace of the black precipitate was placed on a platinum wire and the spectrum line for thallium observed in a small non-luminous flame placed in front of the adjusted spectroscope.

The most distinctive and intense line is one of wave length 5350·5 in the green end of the spectrum. A blank was conducted with all re-agents used throughout the examination with a negative result.

To obtain a permanent record of thallium in the mica from Londonderry, two grams of mica were taken and treated by the method given for the qualitative spectrum examination for thallium on the visual instrument. Again the carbon arc was used for exciting the spectra, and a solution of thallium nitrate used to give a standard spectrum for reference to the spectrum obtained from the mica. Both exposures were made on the same plate and so the spectra were easy to compare. This plate confirmed the presence of thallium in the biaxial mica from Grosmont Mica Mine, Londonderry.

7.—BEES IN THE COLLECTIONS OF THE WESTERN AUSTRALIAN MUSEUM AND THE AGRICULTURAL DEPARTMENT, PERTH.

By TARTLTON RAYMENT.

Read 12th May, 1931. Published 10th July, 1931.

In addition to the bees in the institutions mentioned, and which I have studied owing to the courtesy of the Curator, Mr. L. Glauert, B.A., and the Entomologist to the Department, Mr. L. J. Newman, I have included several West Australian species obtained by Mr. Tom Greaves, myself, and other Collectors. The species in the Museum are marked with an asterisk.

It will be noticed that I have a systematized form for the specific descriptions, and this permits the student to make rapid comparisons. The DIVISIONS and FAMILIES are those of Messrs. Cockerell and Robbins (1), and the neururation of the wings is based on the arbitrary method of Messrs. Rohwer and Gahan (2). Systems based on the homology of the hymenopterous nervures with those of other Orders are too cumbrous for taxonomy.

I regret very much to hear from my esteemed mentor, Professor T. D. A. Cockerell, of Colorado, U.S.A., that owing to ill-health, he has had to return unstudied several boxes of Australian bees. "It will have to be a job for the Australians," he concludes regretfully. The Professor has described many hundreds of our bees.

A study of the strigil of bees, in most of the genera of the world, shows it to be an interesting character in generic diagnosis, and its importance is shown in the new genus *Nodocolletes*. I hope to publish a paper on this character during the year. I tender my sincere thanks to Miss Joyce Love for her careful assistance in the preparation of the typescript.

DIVISION COLLETIFORMES.

FAMILY PROSOPIDIDÆ.

GENUS *HYLAEUS*, Fabricius.

1793.—*Hylaeus*, Fabricius, Ent. Syst. ii, p. 302.

1879.—*Hylaeus obtusata*, Smith.

Hab.—Swan River, W.A., January (L. J. Newman).

A male and female taken at the type locality; the latter is typical, but as I am unable to find any description of the former, I give the following details of the allotype:—

Male: Length, 6.5 mm. approx.

Head elongate, black, coarsely punctured; face-marks wide, yellow, extending half-way to ocelli past the insertion of the antennae; frons shining, deeply and densely punctured; clypeus deep yellowish, red anteriorly; supraclypeal area dome-shaped, yellow; labrum blackish; mandibulae black, a lighter subapical patch; scape yellow, flagellum ferruginous beneath.

Prothorax black, two yellow lines; tubercles yellow; mesothorax black, bright, coarsely and densely punctured; scutellum and post-scutellum with a yellow patch, but of similar sculpture; abdomen blackish, with a purplish tinge, numerous coarse punctures; metathorax with a V-shaped rugose area.

Legs blackish-red; this obscure tint also shows in the middle of the abdominal segments in some lights; a few white hairs; wings clear, nervures and pterostigma reddish-brown; basal nervure arched; first recurrent and intercubitus interstitial.

Close to *H. cognata*, which has no yellow on its smaller prothorax.

*1879.—*Hylaeus cognata* (Smith).

Hab.—Swan River, W.A., January (L. J. Newman); Champion Bay, W.A., February, 1914 (L. Glauert).

Three males and a female from the type locality. These are close to *H. obtusata* (Sm.), but are typical specimens.

GENUS MEROGLOSSA, Smith.

1853.—*Meroglossa*, Smith, Cat. Hym. B.M., p. 33.

*1930.—*Meroglossa miranda*, Rayment. Proc. Roy. Soc. Vic., September (with figure).

Hab.—Milly Milly, W.A., May 10, 1922 (L. Glauert).

This extraordinary bee has a huge transverse process on the fourth abdominal segment, and a nodose one on the third; another very remarkable character is the exceedingly long maxillary palpi, which are very much longer than the antennae; the short, pointed glossa, however, is typical of the genus. The only other *Meroglossa* recorded for the State is *M. rubricata* (Sm.), Swan River, a red bee with yellow markings, and, therefore, entirely distinct from *M. miranda*, which is black.

GENUS EURYGLOSSIDIA, Cockerell.

1910.—*Euryglossidia* Cockerell, Ann. Mag. Nat. His. (8) VI., p. 358.

*1929.—*Euryglossidia cyanescens* Cockerell, "Bees in Australian Museum," p. 219.

Hab.—Cunderdin, W.A., July, August, September, October (L. Glauert). Described from Kojarena, W.A.

The two females are typical in every character.

GENUS EUPROSOPIS, Perkins.

1912.—*Euprosopis* Perkins, Ann. Mag. Nat. His. (8) IX., p. 106.

*1930.—*Euprosopis elegans* var. *occidentalis* Rayment, Proc. Roy. Soc., W.A., p. 47.

Hab.—Gosnells, W.A., February (H. W. Andrewartha).

Previously recorded from Bungulla, W.A.

The lone male is much smaller than eastern varieties of this species, measuring only 6 mm. in length. There is a large black median patch on the basal segment of the abdomen; the mandibulae, labrum and yellow face resembling the male of the species; the apex of the lateral face-marks being somewhat expanded. Specimen in Perth Ag. Dept. Collection.

GENUS *PACHYPROSOPIS*, Perkins.

1908.—*Pachyprosopis* Perkins, Proc. Hawaiian Soc. II., p. 29.

*1913.—*Pachyprosopis haematostoma* Cockerell.

Hab.—Gosnells, W.A., February (L. J. Newman).

Previously recorded from Windsor, Croydon, Vic. ; Kalamunda, W.A.

These females are typical, except that the tarsi are cream-coloured, instead of ferruginous, as in the type.

DIVISION COLLETIFORMES.

FAMILY COLLETIDAE.

GENUS *ANTHOGLOSSA*, Smith.

1853.—*Anthoglossa*, Smith, Cat. Hym. B.M. (1), p. 16.

1906.—*Anthoglossa aureotincta*, Cockerell.

Hab.—Perth, W.A. (L. J. Newman).

A typical female from the type locality.

Anthoglossa vittata, sp. nov.

(Plate XX., Nos. 17, 18, 19).

Female : Length, 14.5mm. approx.

Head transverse, black, bright, numerous large punctures, and much drab hair tipped with black ; face-marks nil, but a dense coat of hair ; frons densely and coarsely punctured ; clypeus wide, coarsely punctured, with much hair ; supraclypeal area rising to a carina that encircles the median ocellus ; vertex sharply developed, not so hairy, a thick post-occipital fringe ; compound eyes blackish, anterior margins parallel, minute peg-like hairs between the facets ; genae rough, a minute shagreen, a few pale hairs, not well developed ; labrum oval, black ; mandibulae with outer edge convex, but not bent ; antennae black, the apical joint oblique, truncated, shining, reddish.

Prothorax not visible from above ; pleura with long, plumose drab hair ; tubercles black, hidden under the abundant yellowish-drab hair ; mesothorax black, bright, scattered coarse punctures, a delicate tessellate sculpture, a thick covering of long yellowish-drab hair tipped with dark brown ; scutellum and postscutellum dull, sculpture rougher, dense hair ; metathorax with a large shining enclosed area having a fine tessellate sculpture ; abdominal dorsal segments black, shining, hind margin of one depressed, margins broadly pallid, three, four and five with a fringe of whitish hair, the black portions with suberect long black hair ; apical fimbria blackish-brown ; ventral segments similar, but hair-fringes dull fulvous.

Legs obscurely reddish, with much light-brown and white plumose and forked hairs ; tarsi fulvous, deeply bifid ; empodium large, dark ; hind calcaria fulvous, with long coarse serrations ; tegulae dark-apricot colour ; wings sub-hyaline, brownish, anterior 9.5mm. ; nervures brownish-amber, strong, first recurrent entering second cubital cell at middle, second recurrent entering third cubital at extreme apical corner ; cells : the second cubital almost rectangular, large, the third cubital contracted at apex ; pterostigma brownish-amber, inconspicuous ; hamuli sixteen in number, strongly developed.

Locality : Perth, W.A.

Allies : *A. cygni* Cockerell, which has no hair-bands on abdomen, a ferruginous labrum, and is larger ; *A. plumata*, Smith, which has orange-fulvous hair on fifth abdominal segment.

Type in the collection of the author.

GENUS PARACOLLETES, Smith.

1853.—*Paracolletes*, Smith, Cat. Hym. B.M., p. 6.

1879.—*Paracolletes bimaculatus* Smith.

Hab.—Smith's Mill, W.A., October 16, 1909 (H. M. Giles).

Previously recorded from Swan River, Yallingup, Perth.

Two females which are much larger than the genotype, being 15mm. against the 11mm. of Smith's specimen. The following details were omitted by that author—the anterior edge of the broad clypeus is narrowly ferruginous, the scattered punctures extremely shallow ; labrum clear ferruginous ; the straight mandibulae ferruginous, with blackish-red tips ; the large scattered punctures of the mesothorax are shallow ; the clear ferruginous abdomen is covered with minute appressed black hairs ; the hind calcar is red, with eight strong teeth.

*1879.—*Paracolletes antennatus* Smith.

Hab. —Swan River, W.A. (L. J. Newman, L. Glauert).

A number of males from the type locality. Smith's words in reference to the apex of the antenna seem contradictory, "dilated and compressed." I think flattened and expanded are more suitable for the peculiar black apical segment.

1929. *Paracolletes melbournensis clarki*, Cockerell.

Hab. —South Perth, W.A., January 21, 1909 (H. M. Giles).

Previously recorded from Perth (J. Clark).

One female, which is not so brassy as the type of the species.

*1853. *Paracolletes plumosus* Smith.

Hab.—Swan River, W.A., February, 1914 (L. Glauert).

Previously recorded from Perth, W.A. ; Melbourne, Bright, Sandringham, Victoria (Rayment).

There has been some doubt about the male, but I have a large colony of this species close to my home, and the males from these nests conform to Smith's description of *P. bicolor*, but his account is too meagre. However, two males and two females are indistinguishable from those in the colony at Port Philip, Vic. ; moreover, they are awing at the same period.

*1879. —*Paracolletes marginatus*, Smith.

Hab.—Margaret River District, W.A., October, 1912 (L. Glauert).

Previously recorded from Bright, Cheltenham, Victoria, also from Queensland, and Bridport, Tasmania. This new record is a remarkable extension of range. The eastern species are awing much later (February). The two males differ from the type by having the entire length of the flagellum ferruginous beneath.

*1879.—*Paracolletes providus* Smith.

Hab.—Guildford, W.A., 1915 (L. Glauert) ; Moora, Swan River, W.A. (L. J. Newman).

Previously recorded from Port Philip, Victoria ; Eaglehawk Neck, Tasmania. This new record for the State increases the range immensely. The four females are typical.

*1862.—*Paracolletes advena* Smith.

Hab.—Perth, W.A. ; Brisbane, Stradbroke Island, Q. ; Port Phillip, Vic.

The true male is *P. euphenax*, Ckll. I have thousands of the nests close to my home, and the bees are peculiar in this respect: the species are very abundant every second year. The sexes issue together, at the end of August, from deep shafts in sandy ground. The cell-chambers are lined out with a silvery skin. The stores are a thick batter of honey and pollen, and the entire brood is carried over the winter in larval form. There is no sex attraction for males while the females are on the flowers of *Leucopogon* species, for mating takes place in the shafts. During the night, or when the weather is dull and cold, the males cluster "higgly piggly" in a curled, dried frond of bracken-fern, and from two to three hundred are to be found sheltering in a single cluster. I have given a full account of the life-history in the *Age* newspaper.

Alfken (3), of Bremen (Ger.), suggests that *Andrena infirma* (Erichs.) is the male, but Alfken is incorrect in his surmise. However, I have submitted males, taken *in cop.*, to Professor Cockerell, and he identified them as *P. euphenax*. Moreover, I have had many colonies of *Halictus lanarius*, Sm., close to my home, and Cockerell says it is probable, but not certain, that Erichson had the male of this species in mind.

GENUS TRICHOCOLLETES, Cockerell,

(Plate XXI. No. 1).

1912.—*Trichocolletes*, Cockerell. The Entomologist, XIV., p. 176.

*1862.—*Trichocolletes venusta* (Smith).

Hab.—Swan River, W.A., August (L. J. Newman) ; Cunderdin, W.A., September (L. Glauert).

Previously recorded from Brisbane, Birkdale, Q. ; Hobart, Tas. ; Port Phillip, Black Rock, Daylesford, and Macedon, Vic. This new record for the State is a remarkable extension of range. Two males are larger than eastern specimens, and the bright orange hair of the face is so abundant that all sculpture of the face is hidden. The hair of the thorax is more foxy-red. The season of flight is the same for Victoria, and I have given the life-history in the "Victorian Naturalist," December, 1929. The following key will separate the described species:—

- (1) Narrow body, coarse puncturing on abdomen, pallid apical margins and long black hair on abdominal segments, clypeus and labrum fulvous. *T. dowerinensis*, sp. nov.
- (2) Wider body, fine puncturing on abdomen, golden apical margins of abdominal segments, face-hair paler. *T. venusta* (Sm.).

- (3) Smaller, excessively fine transverse striation on abdominal segments, clypeus naked with a tuft of hair at each side. *T. nigroclypeatus*, Raym.
- (4) Scapes blackish, a tuft of hair in middle of clypeus, body-bands very dull and narrow. *T. tenuiculus*, sp. nov.
- (5) Face-hair very dense, reddish-gold, the body-bands exceedingly golden. *T. daviesiae*, sp. nov.

***Trichocolletes dowerinensis*, sp. nov.**

(Plate XXI. No. 3).

Male : Length, 13mm. approximately.

Head black, dull ; face covered with a dense coat of bright orange hair ; frons rough ; clypeus bright fulvous ; supraclypeal area rising to a nodule ; vertex sharply developed, with a fine sculpture ; compound eyes with anterior margins parallel, claret-brown ; genae with long white hair ; labrum oval, bright fulvous, with a stiff fringe of hair ; mandibulae dark reddish ; antennae dark-brown, the apical segment flattened, the third segment slender.

Prothorax not visible from above ; tubercles hidden under fulvous hair. Mesothorax black, dull, a minute scale-like sculpture, fulvous hair ; scutellum and postscutellum similar ; metathorax small, with somewhat similar sculpture, and orange hair ; abdominal dorsal segments black, dull, hind margins broadly pale straw-colour, dark fulvous hair on one and two, long black hair on others ; ventral segments black, margins narrowly lighter, some pale hair.

Legs ferruginous, with white hair ; tarsi ferruginous, basitarsi broad ; claws reddish, bifid ; hind calcariae finely serrated, ferruginous. Tegulae dark amber ; wings hyaline ; anterior 8mm. ; nervures dark brown ; cells : radial, very long ; pterostigma dark-brown ; hamuli fourteen in number, strongly developed.

Locality : Dowerin, W.A.

Allies : *T. venusta* (Smith), which has finer puncturing on abdomen, and *T. nigroclypeatus* Raym., which has naked black clypeus.

Biological data : The shrill note and extremely rapid flight of the male is distinctive. Examination of the pollen-grains shows that these bees are singularly constant to the pea-shaped flowers of the *Daviesia*. In Victoria to *D. corymbosa*, *D. latifolia*, and *D. ulicina* ; in W.A. to *D. horrida*, and in Queensland to *D. ulicina*.

***Trichocolletes tenuiculus*, sp. nov.**

(Plate XXI., Nos. 4, 5).

Male : Length, 12mm. approximately.

Head black, transverse, bright ; face covered with a dense bright-orange hair ; the anterior portion of the clypeus laterally naked ; frons rough ; clypeus very prominent, black, with dense puncturing ; supraclypeal area with a fine carina reaching to the median ocellus ; vertex sharply developed ; two large depressions at sides of face ; compound eyes with long orange sensory hairs, the anterior margins parallel ; genae with a few fulvous hairs ; labrum oval, fulvous ; mandibulae fulvous, black basally and apically ; antennae black, scape obscurely lighter.

Prothorax not visible from above ; mesothorax black, dull, a close minute scale-like sculpture ; disc almost naked, but abundant long orange hair laterally ; scutellum and postscutellum similar ; metathorax black, dull, with a strong crescentic transverse keel and abundant orange hair, abdominal dorsal segments black, bright, with pallid hind margins and adpressed long black hair ; very few orange hairs ; ventral surface similar, with a few long white hairs.

Legs black, except ferruginous knees and tibiae ; median tibiae with black spot ; tarsi ferruginous ; claws reddish, bifid ; hind calcariae finely serrated, reddish ; tegulae shining black ; wings subhyaline, the costal margin darker, anterior 9mm. nervures dark-brown ; pterostigma dark-brown ; hamuli thirteen in number, strongly developed.

Locality : Canowindra, New South Wales, August 1930. (M. Dwyer).

Type in the collection of the Author.

Allies : Clearly, the species is between *T. venustus* Sm. and *T. nigroclypeatus*, Raym. The first has the face completely covered with orange hair, the second has paler hair and bare clypeus. The species in this genus are difficult to separate unless the genitalia are examined.

Female : length, 14mm., approximately.

Head black, the face covered with scattered pale hair ; the clypeus naked, with conspicuous punctures, shining ; the supraclypeal area rising to a distinct node ; labrum oval, fulvous ; mandibulae reddish, black basally and apically ; antennae black.

Thorax with some drab-white hair tipped with fuscous ; the disc is almost naked compared with the reddish hair of other females in the genus ; abdominal segments black, sericeous, the golden bands of the hind margins being inconspicuous, so that the general aspect of these females is very dull.

Legs black, except dark ferruginous knees tibiae and tarsi ; the femora with much long white plumose hair ; the hair of the tibiae and tarsi being light golden ; tegulae shining black ; hind calcar reddish, with six strong teeth ; wings subhyaline ; anterior 9.5 mm., nervures dark-brown.

Locality : Canowindra, New South Wales, August, 1930. (M. Dwyer).

Allotype in the collection of the Author.

Seven large spines and three small ones in the hind calcar. Just as I had recorded for Victoria *T. daviesiae* males on *Hardenbergia monophylla*, I received these females taken on the same plant in New South Wales.

Trichocolletes Nigroclypeatus, Raym.

VICTORIAN NATURALIST, Dec. 1929, p. 162, with fig. of female.

The male is difficult to distinguish from *T. venustus* if the genitalia be neglected. Compared with *T. tenuiculus*, the colouring is much brighter, the body-bands wide and golden, the scapes bright ferruginous.

Locality : Mt. Macedon, Victoria, October, 1929 (Rayment).

Allotype : in the collection of the Author.

Trichocolletes daviesiae, sp. nov.

(Plate XXI., No. 6.)

Male: Length 13 mm. approximately.

Head black, transverse; face covered with dense orange hair, which is paler at anterior margins of eyes; Frons dull; vertex sharply developed; genae with abundant long white hair; labrum amber; mandibulae amber, black basally, reddish apically; antennae black, scape ferruginous.

Prothorax not visible from above; mesothorax black, dull, a scale-like sculpture, the thorax beneath with much whitish hair, dorsally and laterally the hair is orange; scutellum and postscutellum similar; metathorax with much orange hair; abdominal dorsal segments black, the hind margins glistening golden colour; the ventral surface with much white hair.

Tibiae and all tarsi bright ferruginous, the other portions of the legs black, with much long white hair, claws reddish; hind calcar reddish; tegulae brown; wings subhyaline, anterior 8 mm. nervures brown; pterostigma brown; hamuli twelve in number.

Locality: Heathmont, Victoria, August 30th, 1930. (Rayment.)

Type in the collection of the Author.

Allies: This species is between *T. dowerinensis* and *T. tenuiculus*; the first is separated by its amber clypeus and the second by its inconspicuous body bands.

These males were flying over the purple flowers of the Wild Sarsaparilla (*Hardenbergia*) but females were on *Daviesia latifolia*.

Genus Nodocolletes, gen. nov.

(Plate XIX).

Large, semiprismatic, dark-coloured bees.

Length, 13–15 mm.

Head transverse, with occipital region poorly developed; glossa wide, short and hairy, an undulating line just in front of the paraglossae which are fan-shaped and hairy; four segments in the labial palpus and six in the maxillary; clypeus convex; ocelli in a low curve.

Prothorax not visible from above; tubercles heavily fringed with hair; the postscutellum with a distinctive hollow dentate process obscuring the metathorax.

Legs stout and heavily clothed with forked hair; the strong teeth of the hind calcar of the female corresponding in number with the teeth of the strigil; an agreement not found in any other group. Radial cell pointed off the costa at its apex; the three cubital cells slightly contracted at the apex; the basal nervure straight; hamuli well developed; pterostigma inconspicuous.

Genotype: *N. dentatus*, sp. nov.

Allies: *Paracolletes*, Smith, but that genus is now too comprehensive; the new genus is closer to *Lioproctus*, Smith—which has been merged in *Paracolletes*—when the mouth-parts are studied.

Paracolletes diodontus, Ckll., *Lioproctus vigilans*, Sm. and *P. subvigilans*, Ckll., become *Nodocolletes diodontus* (Ckll.), *N. vigilans* (Sm.), and *N. subvigilans* (Ckll.) respectively.

In his generic diagnosis of *Lioproctus*, Smith describes a naked area on the sixth abdominal segment, but does not mention this character in his specific description of *L. vigilans*. I have not seen the type, but my specimens, which conform to his account, do not exhibit such an area. The following key will enable students to separate the species reviewed and described in this paper.

Female: Length, 14 mm., approximately.

Head royal blue; genae peacock blue; labrum black; flagellum lighter; abdomen shining green; calcar and strigil with five teeth.

Hab.: Moora, W.A. *N. dentatus*, sp. nov.

Female: Length, 12 mm. approximately.

Head dark-blue; genae blue; labrum black; the second abdominal segment with red margin; calcar with four teeth.

Hab.: Quairading, W.A. *N. subdentatus*, sp. nov.

Female: Length, 13 mm. approximately.

Head dark-blue; thorax black; abdomen black, with margins of segments green; calcar not in description.

Hab.: Eradu, W.A., Sept. 8, 1926. *N. diodontus*. (Cockerell).

Female: Length, 12.5 mm. approximately.

Head and thorax black; flagellum fulvous beneath; abdomen olive green, calcar with five teeth.

Hab.: Swan River, W.A. (L. J. Newman). *N. vigilans*. (Smith).

I have had no opportunity to study the types of *Paracolletes subvigilans*, Ckll., and *P. phanerodontus*, Ckll., and cannot say whether they, too, should be included in this new genus, though the scopa has the contrasting black and white hair of the genotype.

Alftken (3) after examining a small collection of bees from Western Australia, thought that the systematic position of some of the genera must be altered. I agree, and regret that Smith's separation of bees with simple calcariae should be disregarded, and the insects returned to *Paracolletes* which has long strong teeth on the calcar.

This paper was in MS. when Doctor Cockerell's descriptions were published in New South Wales.

***Nodocolletes dentatus*, gen. et sp. nov.**

Plate XIX., No. 3).

Female: Length, 14 mm. approximately.

Head broad, dark royal-blue, shining; face-marks nil, but much silvery white hair up to the antennae; frons iridescent, with dense coarse punctures shining; clypeus broad, rugosopunctate, shining, black, a fringe of long black hair; supraclypeal area similar to clypeus, with a carina reaching to the level of the median ocellus; vertex iridescent, coarsely punctured, a few black hairs, ocelli in a low curve; compound eyes with anterior margins parallel; genae peacock blue, shining, coarsely punctured, some long silvery hair on

lower half ; labrum black, dull rough, with a median circular depression ; mandibulae dull, black, smooth, a large tooth and a small one, a few long fulvous hairs ; antennae black, rufous at base and apex, apical segment flattened.

Prothorax not visible from above ; tubercles with a dense covering of long white hair ; pleura peacock blue, rugosopunctate ; mesothorax black, shining, iridescent, blue anteriorly, numerous coarse punctures, scattered long fuscous hair dorsally, sterna with much white hair ; scutellum metallic blue, coarsely punctured, with long fuscous hair ; postscutellum almost hidden, with a long dentate concave process, iridescent blue with fuscous hair in the cavity and a dense fringe of silvery hair underneath ; metathorax short, the enclosed area smooth and shining ; abdominal dorsal segments a brilliant iridescent shining green, the wide depressed apical half being coppery and impunctate, the basal half royal blue, coarsely punctured, laterally a few white hairs, apically a black brush ; ventral segments peacock blue, each with a fringe of white hair.

Legs black, with long black hair above, and long silvery white hair beneath on the hind tibiae ; tarsi black, the basitarsi short and broad, with much black hair ; claws deeply bidentate, reddish ; hind calcariae dark-red, with five long slender teeth ; tegulae black, smooth, bright. Wings dusky with a purplish iridescence, basally hyaline ; anterior 10 mm ; nervures strong, blackish, the first recurrent entering the second cubital cell at the basal third, the basal meets the nervulus ; cells : the second and third cubitals of nearly equal size, the third being the larger ; pterostigma narrow, dark-brown ; hamuli thirteen in number, well developed.

Locality : Moora, West Australia. (L. J. Newman). Date unknown.

Allies : Very close to *Nodocolletes diodontus* (Ckll.) which has a black abdomen with green bands, and black antennae ; *N. subvigilans* (Ckll.) which has a differently shaped process on postscutellum ; *N. subdentatus*, sp. nov., which has a finely striate area of the metathorax, and four slender teeth on the calcar. A smaller bee, which conforms to Smith's description of *Lioproctus vigilans*, has five teeth on the calcar. Type in the collection of the Agricultural Department, W.A.

***Nodocolletes subdentatus*, sp. nov.**

(Plate XIX).

Female : Length, 12mm. approximately.

Head broad, dark-blue, shining ; face-marks nil, a close covering of white hair at sides of face below the insertion of the antennae ; frons iridescent dark-blue, shining, with numerous coarse punctures ; clypeus black, shining, rugosopunctate, supraclypeal area similar to clypeus, with a carina reaching to the median ocellus ; vertex with fuscous hair ; compound eyes slightly converging below ; genae blue, rugosepunctate, with long white hair ; labrum suboval, black, bright, with a central depression ; mandibulae bright, with a very small inner tooth, black, with obscure red tips ; antennae black above, fulvous beneath.

Prothorax not visible from above ; the pleura blue, with fuscous hair, sterna with white hair ; tubercles with a dense fringe of white hair ; mesothorax iridescent black, shining, coarsely punctured, fuscous hair, bluish

posteriorly ; scutellum bluish, coarsely punctured, dark hair ; postscutellum with a fringe of white hair, and a distinctive bidentate process ; metathorax short, the enclosed area with concentric striations ; abdominal dorsal segments iridescent green, the apical half impunctate and shining, the basal half coarsely punctured, two being dull, at base, with a wide reddish margin ; the ventral segments blue, with a white fringe.

Legs black, stout, hair of coxae white, hind tibiae with black hair above and white beneath ; tarsi with reddish-brown hair ; claws reddish ; hind calcaria with four long slender teeth, reddish brown ; tegulae black shining ; wings hyaline only basally, dusky over other portion ; nervures blackish-brown ; cells : similar to the genotype ; pterostigma small and narrow ; hamuli thirteen in number, strong.

Locality : Quairading, West Australia.

Allies : very close to *N. diodontus* (Ckll.) which has the metathoracic area smooth, and black antennae.

Type in the collection of the Author.

GENUS STENOTRITUS, Smith.

1853.—*Stenotritus*, Smith, Cat. Hym. B.M., 1, p. 119.

*1930.—*Stenotritus glauerti* (Rayment), Victorian Naturalist, p. 10.

This beautiful large green female is close to *S. smaragdinus*, Smith.

Hab.—Yorkrakine, W.A.

1930.—*Stenotritus pubescens* var. *splendida* Rayment.

Hab.—Geraldton, W.A. (L. J. Newman).

GENUS MELITRIBUS, Rayment.

1930.—*Melitribus*, Rayment, Proc. Roy. Soc., Victoria, p. 219.

1930.—*Melitribus victoriae* var. *B* Rayment, Victorian Naturalist, p. 10.

Hab.—Swan River, W.A. (L. J. Newman).

One male. These shining black bees have a strong superficial resemblance to leaf-cutting bees (*Megachile*).

DIVISION ANDRENIFORMES.

FAMILY ANDRENIDAE.

SUBFAMILY HALICTINAE.

GENUS HALICTUS, Latreille.

(Plate XVII).

1805.—*Halictus* Latreille, His. Nat., xiii., p. 364.

1879.—*Halictus vividus*, Smith.

Hab.—Kalgoorlie, W.A., August (L. J. Newman).

One female that conforms to Smith's specimen, with the exception of the tegulae, which are clear glassy ; the type form is rufotestaceous. It is extremely close to *H. victoriae* Cockerell, which was collected by me, at Sandringham, Victoria. *H. victoriae* has a wide smooth shining rim enclosing the

rugose area of the metathorax ; *H. vividus* has the area covered with fine striae. The hind calcar of both species has one long obtuse tooth, similar to that of *H. greavesi* in the illustration. The third intercubitus and second recurrent nervures are weak in both ; almost obsolete in *H. victoriae*.

The type was described from Swan River.

1879.—*Halictus punctatus*, Smith.

Hab. —Champion Bay, W.A. (Collector unknown).

Previously recorded from Rutherglen, Dandenong, Vic. ; Sydney, N.S.W. ; Brisbane, Q.

There are several species of small *Halicti* that have a dark-green head and thorax, with a chestnut red abdomen. The dark parts are usually highly iridescent, while the second recurrent and third intercubitus nervures are greatly weakened. These features seem to bring the bees within the sub-genus *Chloralictus* Rob.

A few, such as *H. raymenti*, Ckll., have jet-black, highly-polished males that are utterly unlike the female ; other males are not so strikingly unlike ; the head, short antennae and colour strongly resembling the females. Critical study has shown the need for separating these groups from the comprehensive genus *Halictus*, and I propose to publish a paper on these during the year.

However, for the present, I confine myself to seven females that have a strong resemblance. The drawing shows the rugose area of the metathorax, the fine sculpturing of the part that is not covered with rugae, and the tibial spur of the hind leg of each bee ; these characters, taken in conjunction with the following key, will assist the student to separate the bees which measure about 5 mm. in length.

Female : Antennae black ; metathorax blackish ; abdomen a clear chestnut-red without any black ; calcar with three short teeth diminishing in size.

Hab. : Port Phillip, Vict., *Halictus tarltoni*, Ckll.

Female : Antennae dark above, fulvous beneath ; metathorax dark bottle-green, iridescent ; abdominal segments 2–5 suffused with dark brown ; calcar with three long teeth diminishing in size.

Hab. : Champion Bay, W.A. ; Purnong, S.A. ; Mackay and Brisbane, Queensland. *H. vitripennis*, Sm.

Female : Antennae black ; metathorax black ; abdominal segment one with a large black patch basally, a black spot laterally on the others ; calcar with four teeth diminishing in size.

Hab.—Port Phillip, Vict. *H. raymenti*, Ckll.

Female : Antennae dark above, light beneath ; metathorax very light iridescent green ; no black on abdomen ; calcar with three teeth diminishing in size, and an indented edge beyond.

Hab.—Perth, W.A. *H. occidentalis*, Raym.

Female : Only flagellum lighter beneath ; metathorax light green, iridescent ; abdominal segment one dark bronze with a red margin ; calcar with one long tooth, and a narrow undulate edge beyond.

Hab.—Perth, W.A. *H. greavesi*, Raym.

Female: Scapes dark, flagellum pale fulvous; metathorax blackish-green; a short blackish median band on abdominal segments 1-3; calcar with one long tooth and a wide undulate edge.

Hab.—Perth, W.A. *H. glauerti*, sp. nov.

Female: Antennae dark; metathorax dark bottle-green, irregular dark markings on dorsal surface of abdominal segments; calcar with four teeth and a small undulate edge beyond.

Hab.—All States of Australia. *H. punctatus*, Sm.

Male: Length, 4 mm. approximately.

Similar to female in colour, antennae not very long, but entirely light fulvous; tubercles clear yellow; legs lighter than those of females; calcar finely serrated.

Hab. Perth, W.A. *H. vitripennis*, Smith.

Male: Length 4 mm. approximately.

Polished jet-black, quite unlike the female; calcar finely serrated.

Hab. —Port Phillip, Vict. *H. raymenti*, Ckll.

*1879.—*Halictus vitripennis*, Smith.

Hab.—Perth., W.A., February, 1914 (L. Glauert).

Six females that conform very well to Smith's description, which is a meagre one. The specimens have the anterior half of the clypeus ferruginous which is separated from the black by a dark-purplish band. A lengthy series of this species shows that the blackish marks on the abdomen are very variable. A description of the Allotype is included.

*1910.—*Halictus chapmani*, Cockerell.

Hab.—Denmark, W.A.

Previous record, W.A., October, 1929 (Tom Greaves).

Six females of typical form. These have a superficial resemblance to *H. victoriellus*, Ckll., which are common along the shores of Port Phillip, Vict.

1916.—*Halictus brazieri*, Cockerell.

Hab.—Denmark, W.A., October, 1929 (Tom Greaves).

A typical female. Previously recorded from Yallingup, W.A.

*1914.—*Halictus erythrurus*, Cockerell.

Hab.—Perth, W.A., October, 1929 (Tom Greaves).

Previously recorded from York, W.A.; Brisbane, Q.; entire Eastern shore of Port Phillip, Croydon, Vic.; Launceston, Tas.

A number of females. This species is variable, a few having the metathorax black, some green with a deep-blue suffusion, others greenish-bronze. At Port Phillip I have collected three varieties, (A) with pale fulvous gaster; (B) with black bands on the ventral segments; (C) with ten black spots on the ventral segments. A number show a blackish suffusion on the dorsal segments, but I am not able to distinguish any differences in structure. The calcariae of all having one tooth and a wide undulate edge beyond similar to that of *H. glauerti* in the diagram.

Halictus Vitripennis, Smith.

Male : Length, 4·7 mm. approximately.

Head almost circular in outline, blackish-green, iridescent ; face entirely covered with cream-coloured adpressed small scale-like hairs ; frons finely striate ; clypeus clear fulvous, with a bracket-like posterior margin ; supraclypeal area with a minute carina ; vertex with a few hairs, the wine-pink ocelli on an elevation ; compound eyes claret-brown, converging above and below ; genae finely punctured, adpressed white hair ; labrum fulvous ; mandibulae fulvous, with red tips ; antennae entirely clear fulvous.

Prothorax not visible from above ; tubercles clear fulvous ; mesothorax iridescent green, polished, minute scattered punctures, scattered fine cream hair ; scutellum similar in sculpture, but slightly blue ; postscutellum rougher, otherwise similar to scutellum ; metathorax iridescent blackish-green, the area lighter green with anastomosing rugae at base, a fine scale-like sculpture posteriorly ; abdominal dorsal segments one and two clear ferruginous, three and four black, with light hind margins, five and six fulvous ; ventral segments dark amber, a few white hairs.

Legs clear fulvous with sparse white hair ; tarsi similar ; empodium darker ; claws fulvous ; hind calcariae fulvous, finely serrated ; tegulae fulvous. Wings hyaline, extremely iridescent, anterior 3·8 mm. ; nervures palest amber, third intercubitus and second recurrent weak ; cells : radial large ; pterostigma pale amber ; hamuli seven in number, weakly developed.

Locality.—Perth, W.A., January (Rayment).

Allies : Close to *H. occidentalis*, Raym., which has no black on abdomen, and antennae darker above. I associate the sexes from their having been taken together on the same flowers. The species might be included in the subgenus *Chloralictus*, Rob.

Allotype in the Collection of the Author.

Halictus glauerti, sp. nov.

(Plate XVIII., No. 22.)

Female : Length, 5 mm. approximately.

Head circular in outline, iridescent green, shiny, with short white hair ; face-marks nil ; frons finely rugosopunctate ; clypeus with scattered coarse punctures, a purple patch on the disc ; supraclypeal area with a purple spot ; vertex roundly developed, with wine-pink ocelli ; compound eyes claret-brown, reniform ; genae striate, some adpressed hair, and a few long ones, large for a *Halictus* ; labrum light brown, tending to fulvous ; mandibulae fulvous, red apically, blackish basally ; antennae with black scapes, flagellum light-fulvous beneath.

Prothorax not visible from above ; tubercles fulvous ; mesothorax iridescent olive green, the disc polished greenish-purple with numerous fine punctures of two sizes, scattered white hair, delicately cancellate ; scutellum similar to mesothorax, including the median patch of purple ; postscutellum rough, olive-green, but no purple ; metathorax blackish-breen, bright, an enclosed area of fine anastomosing rugae. Abdominal dorsal segments clear fulvous, a suffused dark band on one to three ; ventral segments similar, a few scattered whitish hairs.

Legs fulvous, coxae and femora basally darker, scattered white hairs ; tarsi fulvous ; claws bifid, fulvous ; hind calcariae fulvous, with one long tooth, and a broad wave-like edge beyond ; tegulae fulvous. Wings hyaline, iridescent, anterior 3.5 mm. ; nervures palest amber, third intercubitus and second recurrent weakened ; cells normal ; pterostigma palest amber ; hamuli six in number, weakly developed.

Locality.—Perth, Western Australia, February (Rayment).

Allies : Extremely close to *H. vitripennis*, Smith, and the several others of this group included in the key, but critical study with the microscope can detect well-marked differences.

Type in the collection of the Author.

* *Halictus bremerensis*, sp. nov.

(Plate XX., No. 21.)

Female : Length, 5 mm. approximately.

Head almost circular, iridescent olive-green, sparse white hair ; face-marks nil ; frons finely striate longitudinally ; clypeus with a large purple patch on disc, coarse scattered punctures ; supraclypeal area similar to clypeus, but minus the purple ; vertex with transverse striation at a right angle to that on frons ; compound eyes blackish, reniform ; genae striate, with a few white hairs ; labrum dark brown ; mandibulae obscurely reddish ; antennae submoniliform, black.

Prothorax not visible from above ; pleura all finely striate ; tubercles dark-green ; mesothorax of a beautiful coppery iridescent green, numerous coarse punctures, and a well-defined tessellate sculpture ; scutellum similar in sculpture to mesothorax, but scarlet coppery ; postscutellum rugose green, but not coppery ; metathorax iridescent olive-green, with a large area of fine anastomosing rugae, a few yellowish hairs posteriorly ; abdominal dorsal segments purplish-black, bright, the hind margins narrowly lighter a fine transverse striation ; ventral segments similar, with a scopa of curled white hair.

Legs obscurely dark-red, with white hair ; tarsi lighter red, with yellowish hair ; claws bifid, ferruginous ; hind calcariae fulvous, with three strong teeth ; tegulae fulvous anteriorly, darker posteriorly ; wings hyaline, iridescent, anterior 4 mm. ; nervures amber, the second recurrent and third intercubitus weak ; cells normal ; pterostigma large, amber-colour ; hamuli seven in number, weak.

Locality.—Bremer Bay, W.A., January, 1916 (L. Glauert).

Allies : This bee has a strong superficial resemblance to *H. demissus*, Cockerell, which has a faint sculpture on mesothorax, and sparse puncturing with radiating rugae on metathorax. There was an interesting cluster of mites on the basal segment of the abdomen.

Type in the Perth Museum.

SUB-FAMILY NOMIINAE.

GENUS *NOMIA*, Latreille.

1805.—*Nomia*, Latreille, His. Nat., xiii., p. 369.

*1875.—*Nomia australica*, Smith.

Hab.—Harvey, W.A., January (L. J. Newman).

Previously recorded from Melbourne, Vic. ; Brisbane, Stradbroke Is. Q. ; Adelaide, S.A. ; Swan River, W.A.

Compared with females from the Eastern States these bees have lighter face-hair, and the abdominal hair-bands are darker orange.

*1905. *Nomia flavoviridis*, Cockerell.

Hab.—Gosnells, W.A., March (H. Andrewartha) ; Perth, W.A., (L. Glauert).

Subspecies and varieties of this have been recorded from all the Australian States except Western Australia, so these new records are interesting. The five western females have a strong crimson iridescence on the mesothorax, and may be known as a new variety *rubra*. Queensland has a variety *doddi*, whose mesothorax has a deep blue iridescence. This species, and its numerous subspecies and varieties, may be regarded as the most widely distributed of all the bees in the genus.

SUBFAMILY HALICTINAE.

GENUS PARASPHECODES, Smith.

1853.—*Parasphecodes*, Smith. Cat. Hym. B.M., i., p. 39.

1853.—*Parasphecodes lichatus*, Smith.

Hab. : Swan River, W.A., March. (L. J. Newman).

Previously recorded from West Australia ; Port Phillip, Dandenong, Vic.

These red-bodied bees are typical. Smith's descriptions of the species in this genus are seldom full enough. Only a few *Parasphecodes* have been described from the West, the genus being much more in evidence in the Eastern portion of the Commonwealth.

DIVISION ANDRENIFORMES.

FAMILY MELECTIDÆ.

GENUS CROCISA, Jurine.

(Plate XX).

*1807.—*Crocisa* Jurine, Nouv. meth. class., Hym. p. 239.

Crocisa albifrons, sp. nov.

Female : Length, 12·5 mm.

Head small, black, almost entirely covered with long white hair ; face-marks nil ; frons with deep dense punctures ; clypeus with a median depression at anterior, which is naked ; vertex with less white hair and a few black ones ; compound eyes brown ; genae with much white hair ; labrum quadrate, with two nodules laterally ; mandibulae black, with a large median light ferruginous patch ; antennae black.

Prothorax black, with a thick fringe of white hair ; mesothorax black, bright, numerous deep punctures and short black hair ; white marks as follows : a fine line along anterior margin and two lateral spots contiguous to it,

with a longer median patch, four evenly-spaced spots on disc, two at each side divided by the black tegula ; pleura covered with white hair ; sterna naked, black, coarsely punctured ; margin of black scutellum W-like, a few black hairs laterally, some white hair under middle ; abdomen black, bright closely punctured, with short black hair, white marks as follows : anterior margin with two semicircular spots laterally, and two circular spots dorsally on segment one, two lateral and dorsal spots combined on segment two, all others with two lateral and two dorsal spots distinct ; all ventral segments with a minute spot laterally.

Legs black, exterior with much white hair ; all basitarsi with long black hair and white hair exteriorly, other segments black ; apical half of anterior wings clouded, with two hyaline spots ; length, 11 mm. ; posterior wings hyaline ; hamuli nineteen ; nervures black, pterostigma weak ; hind calcar black, bent, finely serrated.

Locality : Landor Station, W.A., 1929. (L. Glauert).

Allies : *C. tincta*, Ckll., which has blue patches on abdominal dorsal segments and no spots on venter. *C. albopicta*, Ckll., which has a white spot at middle of base of first segment. *C. albomaculata*, Sm., which has a white spot on each side of basal segment.

*1913.—*Crocisa wdroonensis*, Cockerell.

Hab. : Dowerin, W.A. (L. J. Newman).

A specimen from a new locality is undoubtedly the undescribed female, A typical male from another district.

Hab. : Landor Station, W.A., 1929. (L. Glauert).

Previously recorded from Waroona, Swan River, W.A.

Allotype : Female : Length, 12 mm. approximately.

Head black, small, face with a large thick tuft of white hair ; vertex with ocelli on a prominence, the occipital fringe extending down to meet the white hair of the genae.

The anterior half of the mesothorax covered with bluish-white hair, a spot of white hair on axilla, a large patch laterally on anterior margin of mesothorax, a bar of pale hair on posterior margin of scutellum ; pleura with a large patch, and a small one laterally on metathorax ; hind margin of scutellum bracket-shaped. Abdominal segment one with a large hour-glass-shaped patch laterally, three and four with subovate patch laterally, and two circular spots dorsally, four and five with suboval spot dorsally ; ventral segments with a minute spot laterally.

Legs black, all tibiae with white hair exteriorly, median and posterior basitarsi with a minute spot basally ; hind femora armed at the base with a stout tooth ; apical half of anterior wings fuscous with hyaline small spots, posterior wings clear ; hamuli seventeen ; nervures blackish ; hind calcariae black, finely serrated.

These spotted bees are well-covered with pollen-granules of three kinds, probably from wattles (*Acacia* sp.)

The fleece, too, is full of small pebbles, indeed, the mandibulae of one are grasping a grain of quartz. I do not believe these bees are entirely parasitic, for I have known some to carry pellets of mud.

* *Crocisa rufitarsus*, sp. nov.

(Plate XX.)

Male: Length, 9 mm. approximately.

Head small, black, bright; face-marks confined to a little greenish-blue at sides of face; frons deeply coarsely and densely punctured; clypeus black, bright, coarsely and densely punctured; supraclypeal area rising to a carina, with scattered blue hair; vertex with ocelli in a low curve; compound eyes light-brown, minute peg-hairs between the facets; genae with narrow line of blue hair along posterior orbital margin; labrum black, with two reddish nodules; mandibulae red, black basally and apically; antennae black above, reddish beneath (in bad condition).

Prothorax black, a bluish-green patch laterally; tubercles black, with a few long white hairs; a large semicircular patch on pleura; mesothorax black, shining, four bluish-green spots on disc, a blue line along margin of the tegulae, two minute dots and a median patch on anterior margin; coarse punctures; scutellum with a bracket-like margin, polished, with numerous punctures; metathorax not visible from above; abdominal dorsal segments black, a minute transverse striation; coarsely punctured; a few black hairs; one with a fine line basally and a large green patch laterally; two to five with a short wide patch laterally; venter black.

Legs dark-reddish, all the tibiae having thin blue hair exteriorly; tarsi reddish; claws reddish; hind calcariae black, finely serrated; tegulae black, bright, with a minute tessellate sculpture and deep punctures; wings clouded, two small hyaline spots, anterior 7.5 mm. Nervures blackish, basal straight; cells: the secone cubital cell roughly hexagonal; pterostigma dark-brown, small; hamuli nineteen in number.

Locality and Collector unknown.

Allies: *C. caerulifrons*, Kirby, which is larger, with blue spots, and black legs. *C. rufitarsus* is easily known from all others by its small size and red legs.

DIVISION MEGACHILIFORMES.

FAMILY MEGACHILIDAE.

SUBFAMILY MEGACHILINAE.

GENUS MEGACHILE, Latreille.

1802.—*Megachile*, Latreille, His. Nat., iii., p. 382.

*1868.—*Megachile sexmaculata*, Smith.

Hab.—South Perth, W.A., February (L. Glauert); O'Connors, W.A., December (L. J. Newman).

Previously recorded from Perth, Yallingup, and Champion Bay, W.A. Two typical females from the first named locality, and two slightly larger females from the second.

*1910.—*Megachile adelaidae*, var. A., var. nov.

Hab.—Mullewa, W.A., 1927 (L. Glauert).

The type locality of the species is Adelaide, and this western variety may be distinguished from the typical form by the clear wings, black tegulae with pallid anterior margins, black legs and no black hairs in the ventral scopa.

853.—*Megachile maculata*, Smith.

Hab.—Swan River, W.A. (L. J. Newman).

Previously recorded from Port Phillip, Vic. ; Brisbane, Townsville, Cairns, Kuranda, Q. ; Bungulla, W.A., October, 1929 (T. Greaves).

Two males and two females of typical form.

*1853.—*Megachile chrysopyga*, Smith.

Hab.—Swan River, W.A., March (L. J. Newman); three typical females and two males. Badgerup, W.A., three females; East Perth, one female (L. Glauert). Claremont, W.A., one male (L. Glauert).

Previously recorded from Tasmania, New South Wales, Queensland, and adjacent Islands; Geraldton, Perth, W.A.

*1853.—*Megachile semiluctuosa*, Smith.

Hab.—Swan River, W.A. (L. J. Newman).

Two females of typical form. A new record for the State; the type locality being Adelaide, S.A. Previously recorded from the Mallee, Vic.

1853.—*Megachile heriadiformis*, Smith.

Hab.—Moora and Wyndham, W.A. (L. J. Newman); Bungulla, October, 1929 (Tom Greaves).

Previously recorded from Adelaide, S.A., and Yallingup, W.A.

A typical male and female.

1912.—*Megachile cetera*, Cockerell.

Hab.—Swan River, W.A. (L. J. Newman).

A new record for the State, showing a great extension of range.

Previously recorded from Nagambie, Gippsland, Vic. ; Sydney, Cooma, N.S.W. ; Brisbane, Bribie Island, Q.

Two females of typical form.

1913.—*Megachile rufolobata*, Cockerell.

Hab.—Gnangara, W.A., December (L. J. Newman).

Previously recorded from Perth, W.A.

Two typical females.

1868.—*Megachile monstrosa*, Smith.

Hab.—Moora, W.A. (L. J. Newman).

Previously recorded from Townsville, Q. ; Champion Bay, W.A.

One fine large female.

1853.—*Megachile erythropyga*, Smith.

Hab.—Swan River, W.A., October (H. Andrewartha).

Previously recorded from Yallingup, Perth, Kalamunda, W.A.

One male showing three white patches laterally on the abdomen. Smith says female has three, but the male only one white patch. The hair-patches are easily dislodged, sometimes coming off on one's fingers.

1910.—*Megachile nasuta argentifer*, Cockerell.

Hab.—Ascot, W.A., December.

Previously recorded from Melbourne, Vic., so this new record for the State proves a large extension of range.

One typical female.

*1853.—*Megachile clypeata*, Smith.

Hab.—South Perth, W.A., January 28th, 1915 (L. Glauert).

Previously recorded from Busselton, Yallingup, W.A.

A female, not quite typical.

1868.—*Megachile nasuta*, Smith.

Hab.—Moora, Swan River (L. J. Newman).

Previously recorded from Champion Bay, Yallingup, W.A. Two typical females from the first locality, and a slightly smaller one from the second.

1906.—*Megachile cygnorum*, Cockerell.

Hab.—Moora, W.A. (L. J. Newman); and Bungulla, W.A. (Tom Greaves).

Previously recorded from Perth, W.A.; Adelaide, S.A.; N.S.W.; Mackay, Q.; Woodend, Vic.

Professor Cockerell has mentioned it is improbable that this be the male of Smith's *M. maculata*; I have both sexes of *M. cygnorum*, collected by Mr. Tom Greaves, at Bungulla, W.A., and there is no confusion when both species are present. The head of this female is larger than that of Smith's bee. These western bees differ from Queensland specimens by having a shorter and stouter abdomen, the nodule between the two dentate processes of the apical adominal segment is more prominent, but there is much long black hair among the dull-yellow inconspicuous apical patch of the abdomen, as described by Smith for *M. maculata*. My Brisbane specimens of *M. maculata* have no such long black hairs in the patch. The first intercubitalia nervure is much more bent in *M. cygnorum*. I append a description of the allotype.

Female: Length, 12.5 mm.

Head wide, black, coarsely punctured, bright, long pale ochreous hair; frons coarsely punctured; clypeus large, coarse punctures, a polished median longitudinal line extending up over the supraclypeal area; genae with dense long white hair; labrum brown; mandibulae black, rugose, with four teeth, very wide; antennae black, reddish beneath.

Prothorax not visible from above; mesothorax black, bright, with dense coarse punctures, black hair on disc, two cream hair-spots anteriorly, four posteriorly; scutellum similar with cream fringe posteriorly; abdomen black, dull, coarsely punctured, long black hair, five hair-bands of deep ochreous hair, one and two broadly interrupted; ventral scopa white; a few long black hairs at apex.

Legs black, with white hair; tarsi black; claws bifid, reddish; calcar dark, simple; tegulae ferruginous with dark patches; wings hyaline, anterior 9 mm.; nervures brownish black; cells normal; pterostigma inconspicuous, dark brown; hamuli sixteen in number, strongly developed.

Locality : Bungulla, W.A., October (Tom Greaves).

Allies : *M. maculata*, Smith, which has much darker hair posteriorly of scutellum, much more hair on face, so that clypeus is not so bare, narrower between the compound eyes.

Megachile Revicta, Cockerell.

Male : Length, 12 mm. approximately.

Head transverse, black, coarsely punctured ; face-marks nil ; a sparse covering of pale golden hair ; frons bright, densely and coarsely punctured, almost naked ; clypeus densely and coarsely punctured ; supraclypeal area similar, but with less hair ; vertex roundly developed ; compound eyes blackish-claret, anterior margins parallel ; genae large, bright, almost naked ; labrum black ; mandibulae black, convex ; antennae very long, black, obscurely reddish beneath.

Prothorax not visible from above ; tubercles black ; mesothorax black, densely and coarsely punctured, a few whitish hairs ; scutellum and post-scutellum similar, the latter more polished ; metathorax with a bright smooth area ; abdominal dorsal segments polished black, numerous coarse punctures, a fringe of long white hair at base of one ; ventral segments not so polished.

Legs black, with sparse white hair, simple ; tarsi black ; claws blackish, and red ; hind calcariae dark-brown, finely serrated ; tegulae blackish, bright, with a few curled white hairs ; wings slightly clouded apically ; nervures blackish ; cells : the radial deeply clouded ; pterostigma inconspicuous, dark-brown ; hamuli eleven in number, of medium development.

Locality : Sawyers Gully, W.A., December. (L. J. Newman). Perth (Tom Greaves).

Allies : I associate the sexes from their having been taken together in the same flowers, but not *in cop*.

I recovered a few Acaridmites from the metathorax of this bee.

Allotype in the collection of the author.

DIVISION ANDRENIFORMES.

FAMILY ANTHOPHORIDAE.

GENUS ANTHOPHORA, Latreille.

1804.—*Anthophora*, Latreille, Hist. Nat. Crust. Ins. xiv., p. 45.

Anthophorae of a dull, mousy-colour are a feature of the collections ; most of them show a black band similar to *Asaropoda*, to which they are closely related. The following key will assist students to separate the species which are not banded with blue.

Female : Length, 15 mm., approximately.

Clypeus black, with a median yellow mark shaped like an inverted champagne glass with a long stem, but no " foot " ; no supraclypeal mark ; a few scattered hairs on face ; anterior legs reddish ; a small appendiculate cell ; body-hairs the colour of a mouse.

Hab. : Geraldton, W.A. *A. grisescens*, sp. nov.

Female : Length, 15 mm., approximately.

Clypeus yellow, with two large brown patches ; tegument of abdomen black, hind margins of segments broadly red ; tegulae clear testaceous.

Hab. : Adelaide, S.A. ; West Australia. *A. scymna*, Gribodo.

Female : Length, 15 mm., approximately.

Clypeus with a yellow mark like an inverted T, the crossarms being longer than the stem ; legs obscurely reddish, tegulae dark-chestnut ; body-hair mousy in colour.

Hab. : West Australia. *A. preissi*, Cockerell.

Male : Length, 13 mm., approximately.

Clypeus with a yellow mark like an inverted T ; tegument of abdomen red ; a tubercle on fourth ventral segment.

Hab. : Mackay, Brisbane, Pinalba, Q. ; W.A. *A. rhodoscymna*. Cockerell.

Male : Length, 18 mm., approximately.

Clypeus with black dot laterally ; two black bands on abdomen ; apex bilobed ; body-hair sienna-colour ; a dark-brown appendiculate cell ; legs dark-brown ; nervures blackish ; first recurrent nervure entering second cubital cell at apical third.

Hab. : Geraldton, W.A. *A. sordida*, sp. nov.

Male : Length, 13 mm., approximately.

Abdomen with one black band ; apex rounded ; clypeus with a dark dot laterally ; body-hair sienna-colour ; legs dark-brown ; nervures light ferruginous ; first recurrent nervure entering second cubital cell at middle.

Hab. : Swan River, W.A. **A. sordidula*, sp. nov.

Male : Length, 10 mm., approximately.

Lateral face-marks paler yellow ; supraclypeal mark a dirty white crescent ; abdomen with dirty-white hair ; hind margins of segments broadly yellowish-white ; legs light-ferruginous ; the greyish hair is sparse.

Hab.—Swan River, W.A. *A. cygni*, sp. nov.

The blue-banded bees are well represented in both collections, and are very distinct from any of the species in the preceding synopsis.

***1905.**—*Anthophora adelaidae*, Cockerell.

Hab.—Wurarga, W.A. (L. Glauert).

A typical male. A new record for the State and a large extension of range.

Previously recorded from Adelaide River, Northern Territory.

***1905.**—*Anthophora walkeri*, Cockerell.

Hab.—Guildford, W.A. (L. Glauert).

A male in bad condition ; the genitalia having been removed. The hair on the hind tarsus of this species is entirely black.

Previously recorded from Baudin Is., Long Reef, W.A.

*1804.—*Anthophora cingulata* (Fabricius).

A large number of males and females from new localities. The hair of the thorax varies in colour from greyish-green to fulvous-green ; with this exception they are similar to Victorian species.

Hab. Waddouring, Wurarga, Perth, Guildford, Badgerbup, Landor Station (L. Glauert) ; Katanning, Wongan Hills, Moora, Beverley (L. J. Newman) ; Stretton (S. Congrieve and B. A. D. O'Connor).

Many of the bees were taken in January, on flowers of *Podalirius*, sp.

Previously recorded from Queensland.

* *Anthophora sordidula*, sp. nov.

(Plate XX, No. 15.)

Male : Length, 13 mm. approximately.

Head transverse, black, bright, with much dull greyish hair ; face-marks yellow, ending abruptly at level of apex of clypeus ; frons with scattered hair ; clypeus yellow, a subtriangular black mark laterally, a few long black hairs ; supra-clypeal area with a long triangular yellow mark ; vertex with a few fuscous hairs ; compound eyes with anterior orbital margins parallel ; genae with long pale ochreous hair ; labrum yellow, a dark macula laterally at base ; mandibulae yellowish with reddish tips ; antennae with front of scapes yellow, flagellum dark-brown, reddish beneath.

Prothorax not visible from above ; tubercles hidden under the long greyish-fawn hair of the pleura ; mesothorax black, shining, coarsely punctured, a dense covering of fawn and black hair intermixed ; scutellum and postscutellum similar to mesothorax ; metathorax coarsely punctured ; abdominal dorsal segments black, apical margins broadly red, one black band, the light-fawn hair being adpressed, the black hairs long and sub-erect ; ventral segments polished.

Legs blackish-brown, with long pale sienna-coloured hair ; anterior legs red ; tarsi sienna-coloured ; claws dark-red ; hind calcariae blackish-red, finely serrated ; tegulae dark-brown basally, reddish apically ; wings subhyaline ; a small appendiculate cell almost complete ; nervures light ferruginous ; cells : second cubital contracted at apex ; pterostigma inconspicuous ; hamuli twenty in number, strongly developed.

Locality.—Swan River, W.A. (L. J. Newman).

Allies : *A. sordida*, sp. nov., and *A. cygni*, sp. nov.

Anthophora cygni, sp. nov.

Male : Length, 10mm. approx.

Head wide, black, bright, with a light covering of mouse-coloured hair ; face-marks truncate at apex of clypeus, yellow ; frons densely punctured, with scattered pale-grey hair ; clypeus yellow, with coarse punctures, scattered pale hair, a dark spot laterally ; supra-clypeal area with a dirty-white crescentic mark ; vertex with pale hair tipped with dirty-yellow ; compound eyes brown, converging slightly below ; genae with a few dull-white hairs ; labrum dull-yellow, not so square, with three small dark maculae basally ; mandibulae yellow basally, tips dark red ; antennae with yellow on front of stout scapes, flagellum dark-brown above, reddish beneath.

Prothorax not visible from above ; tubercles hidden under the mouse-coloured hair of the pleura ; mesothorax black, shining, coarsely punctured, disc almost naked, but surrounded with a fringe of the ubiquitous mixture of hair ; scutellum similar to mesothorax, with long pale hair ; postscutellum similar to mesothorax, but colour light-brown, long pale-grey hair ; metathorax black, shining, coarsely punctured ; abdominal dorsal segments black, apical margins broadly red ; a light covering of pale adpressed hair ; ventral segments ferruginous, with sparse covering of hair.

Legs light-ferruginous, with pale hair ; tarsi red ; claws dark red ; hind calcariae dark blackish-brown ; tegulae very pale-fulvous, with a rim ; wings clear, iridescent ; nervures reddish ; cells : second cubital greatly contracted at apex ; pterostigma inconspicuous ; hamuli strong, seventeen in number.

Locality : Swan River, W.A. (L. J. Newman).

Allies : *A. sordida*, sp. nov., which is much larger, with dark legs. *A. cygni* is easily known by the small size and red legs.

***Anthophora sordida*, sp. nov.**

Male : Length, 18 mm., approximately.

Head transverse, black, shining, densely covered with long, dull-golden hair ; face-marks as high as insertion of the antennae, yellow ; frons short, shining ; clypeus convex, quadrate, subrugose, yellow, with scattered long black hairs, a black mark, shaped like a long triangle, at each side ; supraclypeal area with yellow margin, bracket-shaped ; vertex sharply developed, a few long black hairs among the golden ; compound eyes with anterior orbital margins parallel, light brown ; genae rough, dull, with paler, long hair ; labrum quadrate, yellow ; mandibulae yellow, with reddish tips ; antennae with front of stout scapes yellow, flagellum dark-brown, obscurely lighter beneath.

Prothorax not visible from above ; tubercles covered with long dull-golden hair ; mesothorax dull, black, numerous large punctures, long sordid-gold hair tipped with black ; scutellum similar to mesothorax ; postscutellum similar to scutellum ; metathorax black, with a delicate tessellate sculpture and large punctures ; abdominal dorsal segments black with posterior margins broadly yellow, many punctures, and much long black hair among the dull-gold, apical one widely bilobed ; ventral segments 3, 4, 5, with progressively deeper emargination, reddish.

Legs blackish-red, interiorly with black hair, exteriorly with dull golden hair mixed with black ; tarsi reddish, the basitarsi short and broad ; claws darker red ; hind calcariae dark-red, finely serrated ; tegulae apricot-colour apically, dark-brown basally ; wings slightly yellowish, anterior 10 mm. ; iridescent ; nervures blackish, third intercubitus bowed ; cells : third cubital almost square, second cubital contracted at apex ; a small appendiculate cell stained with dark-brown ; pterostigma inconspicuous ; hamuli twenty in number, strong.

Locality : Geraldton, W.A. (L. J. Newman).

Allies : This may be the male of *A. grisea*, sp. nov., and is close to *A. sordidula*, sp. nov.

Anthophora grisescens, sp. nov.

Female : Length, 15 mm., approximately.

Head transverse, black, dull, sparse pale-grey hair ; face-marks confined to dull-yellow, one shaped like a champagne glass without a foot on the clypeus ; frons with a few pale fawn hairs ; clypeus black, bright, coarsely punctured, a few coarse black hairs laterally, a few pale short hairs on disc ; supraclypeal area similar to clypeus ; vertex with scattered black hair ; compound eyes brown, diverging below ; genae with long fawn and black hair intermixed ; labrum dull-yellow with two reddish nodules at anterior margin ; mandibulae black apically, pale-yellow basally, red median area ; antennae with reddish scape, blackish flagellum, third antennal segment slender.

Prothorax not visible from above ; tubercles hidden under the long mixed light-fawn and black hair of the pleura ; mesothorax covered with the ubiquitous mixture of fawn and black hair ; scutellum and postscutellum similar to mesothorax ; metathorax not visible ; abdominal dorsal segments black, apical margins broadly lighter, numerous punctures, adpressed grey hair, long black hair ; ventral segments black, a few dark hairs.

Legs dark brown, anterior tibiae lighter reddish, with long dull-grey hair ; tarsi reddish ; claws darker red ; hind calcariae brownish-black, finely serrated ; tegulae brown, with a rimmed reddish margin, punctured ; wings subhyaline, the appendiculate area dark-brown ; anterior 11 mm. Nervures blackish-brown ; cells : second cubital contracted at apex ; pterostigma inconspicuous ; hamuli twenty-three in number, strongly developed.

Locality : Geraldton, W.A. (collector not known).

Allies : This may prove to be the female of *A. sordida*, sp. nov., and is also close to *A. sordidula*, sp. nov., *A. cygni*, sp. nov. and *A. preissi*, Cockerell, which has long arms on T of clypeus.

Type in the collection of the author.

Mr. John Clark, formerly of Perth, but now of the Melbourne Museum, informs me that the flora of Landor Station is essentially that of Central Australia, and these new records indicate a wonderful extension of range.

GENUS ASAROPODA, Cockerell.

(Plate XX.)

Asaropoda, Cockerell.

The three new bees described in this paper bring the number of species up to six, and since they are determined only after critical examination, the following key will assist the student :—

Female : Length, 17 mm.

Scape clear ferruginous, flagellum blackish ; mandibles with yellow base, blackish tips, reddish median patch ; eyes dark-claret brown ; face wide ; a fine tessellate pattern between the shallow punctures of the mesothorax ; body-hair intensely red ; hind margins of abdominal segments broadly reddish ; abdominal band intense black ; many long black sub-erect hairs on abdomen ; wings dark-purple ; a small appendiculate area dark-brown. *A. rufa*, sp. nov.

Hab.—Sydney, N.S.W. (L. Robertson).

Female: Length, 15 mm.

Scape ferruginous, flagellum light-brown above, ferruginous beneath; eyes lighter; face narrower; hair of clypeus pale; deep punctures contiguous on mesothorax; body-hair not so red; a few long black suberect hairs on abdomen; wings not so dark; appendiculate area inconspicuous; apex of abdomen with fulvous hair. *A. bombiformis* (Smith).

Female: Length, 16 mm.

Third antennal segment similar to that of *A. bombiformis*, antennae longer; anterior half of second and third abdominal segments slightly greenish.

Hab.—Brisbane, Q. *A. anomala*, Cockerell.

Male: Length, 12 mm.

Lateral margins of clypeus with a broad black band; flagellum ferruginous beneath; bidentate apex of abdomen with black hair; hair on hind tarsi black; legs dark, with much orange hair.

A. alpha, Cockerell.

Male: Length, 12 mm.

Flagellum similar to that of female, with third segment slender and long, the scape yellow in front; black band of body not intense; hair of clypeus pale and there are two small dark spots laterally; wings pale; the second cubital cell is square, and receives the first recurrent nervure at its middle.

Hab.—Q., N.S.W., Vic. *A. bombiformis* (Smith).

Male: Length, 12 mm.

The third antennal segment short and thick; antennae longer; small dot laterally on clypeus; femora clear red; hair on tarsi red; apex of abdomen obtusely bilobed.

Hab. Brisbane, Q. *A. anomala*, Cockerell.

Male: Length, 14 mm.

Face wide; antennae longer, with third segment short, scape dark-ferruginous, with yellow on front, flagellum dark, very long; two dark spots laterally, and two dark-amber short longitudinal bars on yellow clypeus, which also has much long black hair; hair of cheeks pale-ochreous; eyes light-brown; many long suberect black hairs on abdomen; smooth shining areas between the punctures of the mesothorax.

Hab.—Sydney, N.S.W. *A. punctata*, sp. nov.

Male: Length, 12 mm.

Third segment of antenna long and slender, antennae black, with yellow on front of scape, flagellum obscurely red beneath; head small; eyes light-brown; white hair of genae abundant, and in sharp contrast to the intense red of the body; hind margins of abdominal segments broadly red, very few long suberect hairs; large punctures contiguous on mesothorax.

Hab.—Lander Station, W.A. *A. albigena*, sp. nov.

I have not been able to find the nest of these species, though I suspect they avail themselves of any suitable shafts in dry, warm banks. At Bacchus Marsh, in Victoria, these golden bees may be seen hovering over the flowers of "Mistletoe," a parasitic growth commonly found on many of the gum-trees of the district.

DIVISION XYLOCOPIFORMES.

FAMILY CERATINIDAE.

GENUS EXONEURA, Smith.

1854.—*Exoneura*, Smith, Cat. Hym. B.M., ii., p. 232.

1914.—*Exoneura angophorae occidentalis*, Cockerell.

Hab.—Smith's Mill, W.A., September, 1912 ("W.B. Alexander.").

Previously recorded from Kalamunda, October (T. Greaves); Bremer Bay, and Yallingup, W.A.

The several females show variation in the black markings of the abdomen.

1913.—*Exoneura hamulata*, Cockerell.

Hab.—Swan River, W.A., January (L. J. Newman).

Previously recorded from Brisbane, Stradbroke Is., Caloundra, Q.; Moss Bay, N.S.W.; Melbourne, Cann River, Oakleigh, Vic.

A typical female. This new record for the State is a vast extension of range, but I am not surprised as I have a great number of bees of this genus from Western Australia, though only three have so far been described.

1930.—*Exoneura punctata*, Rayment.

Hab.—Perth, W.A. (L. J. Newman).

Previously recorded from Albany, October, 1929 (Tom Greaves).

GENUS XYLOCOPA, Latreille;

SUBGENUS MESOTRICHIA Westwood.

1802.—*Xylocopa*, Latreille, Nat. His. Ins., iii., p. 379.

1775.—*Xylocopa bryorum* (Fabricius).

Hab.—Wyndham, W.A. ? (Collector not known).

Previously recorded from many localities in Queensland and New South Wales. A small but otherwise typical female. If the label on this specimen be correct, then it indicates a wonderful extension of range, but there seems to be some doubt about this.

DIVISION APIFORMES (Social Bees).

FAMILY APIDAE.

SUBFAMILY MELIPONINAE.

GENUS TRIGONA, Jurine.

1807.—*Trigona*, Jurine, Nouv. Meth. Class. Hymen., p. 245.

Although no bees of this genus were in any of the Western Australian collections, their absence surprised me, as I have reliable accounts of their presence in the vicinity of Kalgoorlie and eastwards.

SUBFAMILY APINAE.

GENUS APIS, Linnaeus.

1758.—*Apis*, Linnaeus, Syst. Nat. Ed. 10a, p. 343.

1767.—*Apis mellifera*, Linnaeus (also the subspecies *A. ligustica*) introduced in 1822, are now spread over large portions of the State.

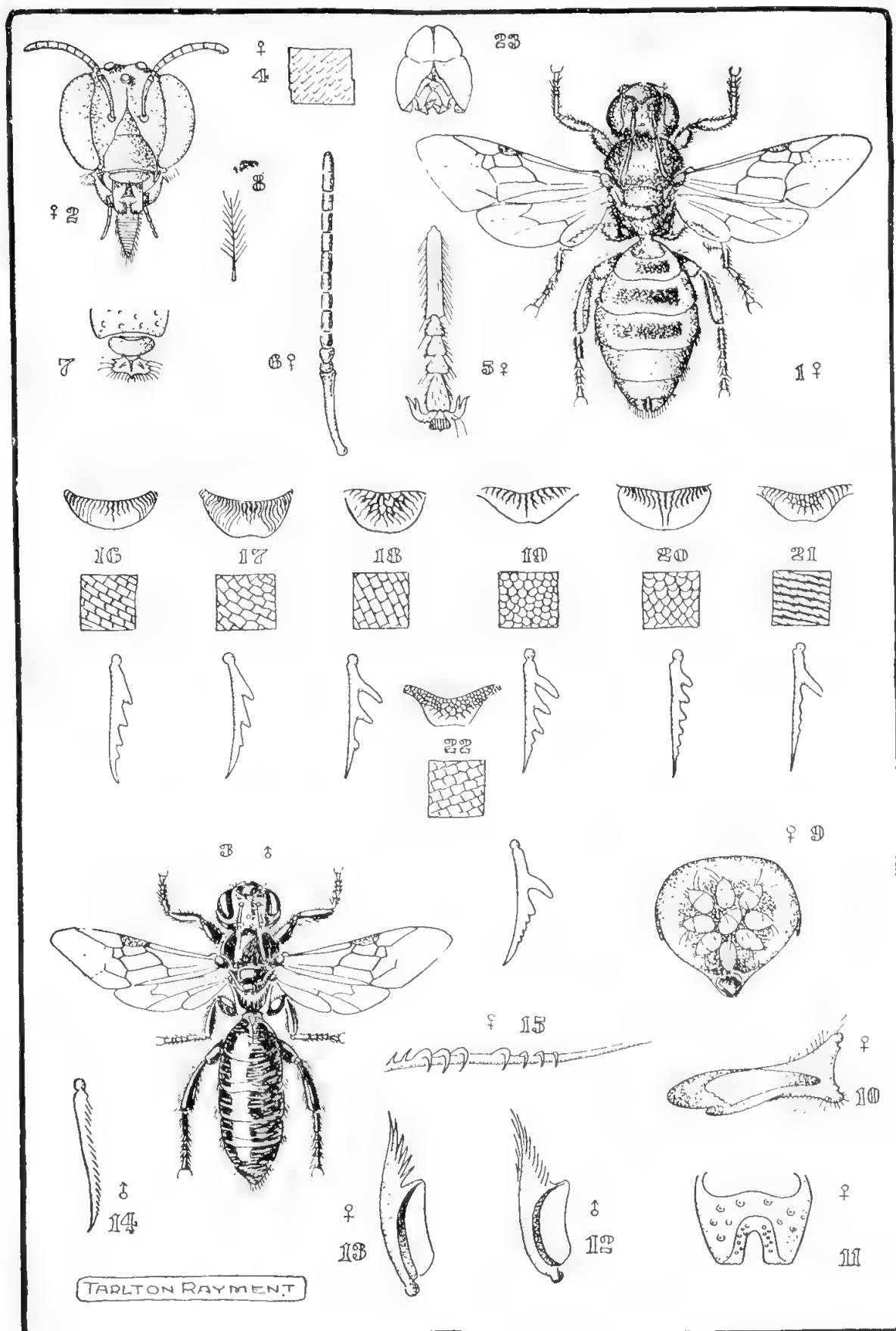
REFERENCES.

1. T. D. A. Cockerell and W. W. Robbins, University of Colorado Studies, 1910.
2. S. A. Rohwer and A. B. Gahan, Proc. Ent. Soc. Washington, 1916.
3. J. D. Alftken, on the *Apidae* in "Die Fauna Südwest-Australiens" Vol. I. Lief. 6, 1907.

EXPLANATION OF PLATE XVIII.

1. Adult female, *Halictus glauerti*, sp. nov.
2. Front view of head-capsule.
3. Adult male, *Halictus raymenti*, Cockerell.
4. Fine hairs covering the wing surface of *H. chapmani*, Cockerell.
5. Tarsal segments and claws of *H. glauerti*, sp. nov.
6. Submoniliform antenna of *H. glauertis*, sp. nov.
7. The *Halicti* have a peculiar appendage to the labrum.
8. One of the small wide plumose hairs that form bands on many of the *Halicti*.
9. Anterior view of basal segment of female *Halictus*, showing a cluster of Acarid mites arranged in a geometrical pattern.
10. View of the inside of mandible of female, *H. raymenti*, Cockerell.
11. Apical segment of female showing the furrow of the Family.
12. Strigil or antenna-cleaner of male *G. raymenti*, Cockerell.
13. Strigil or antenna-cleaner of female *H. glauerti*, sp. nov.
14. Hind calcar of male *H. raymenti*, Cockerell.
15. The hamuli or wing-hooklets of these prismatic *Halicti* are few and weak.
16. Rugose metathorax, surface sculpture and calcar of *H. raymenti*, Cockerell.
17. Rugose metathorax, surface sculpture and calcar of *H. tarltoni*, Cockerell.
18. Rugose metathorax, surface sculpture and calcar of *H. vitripennis*, Smith.
19. Rugose metathorax, surface sculpture and calcar of *H. occidentalis*, Rayment.
20. Rugose metathorax, surface sculpture and calcar of *H. punctatus*, Smith.
21. Rugose metathorax, surface sculpture and calcar of *H. greavesi*, Rayment.
22. Rugose metathorax, surface sculpture and calcar of *H. glauerti*, sp. nov.
23. Genitalia of *H. raymenti*, Cockerell.

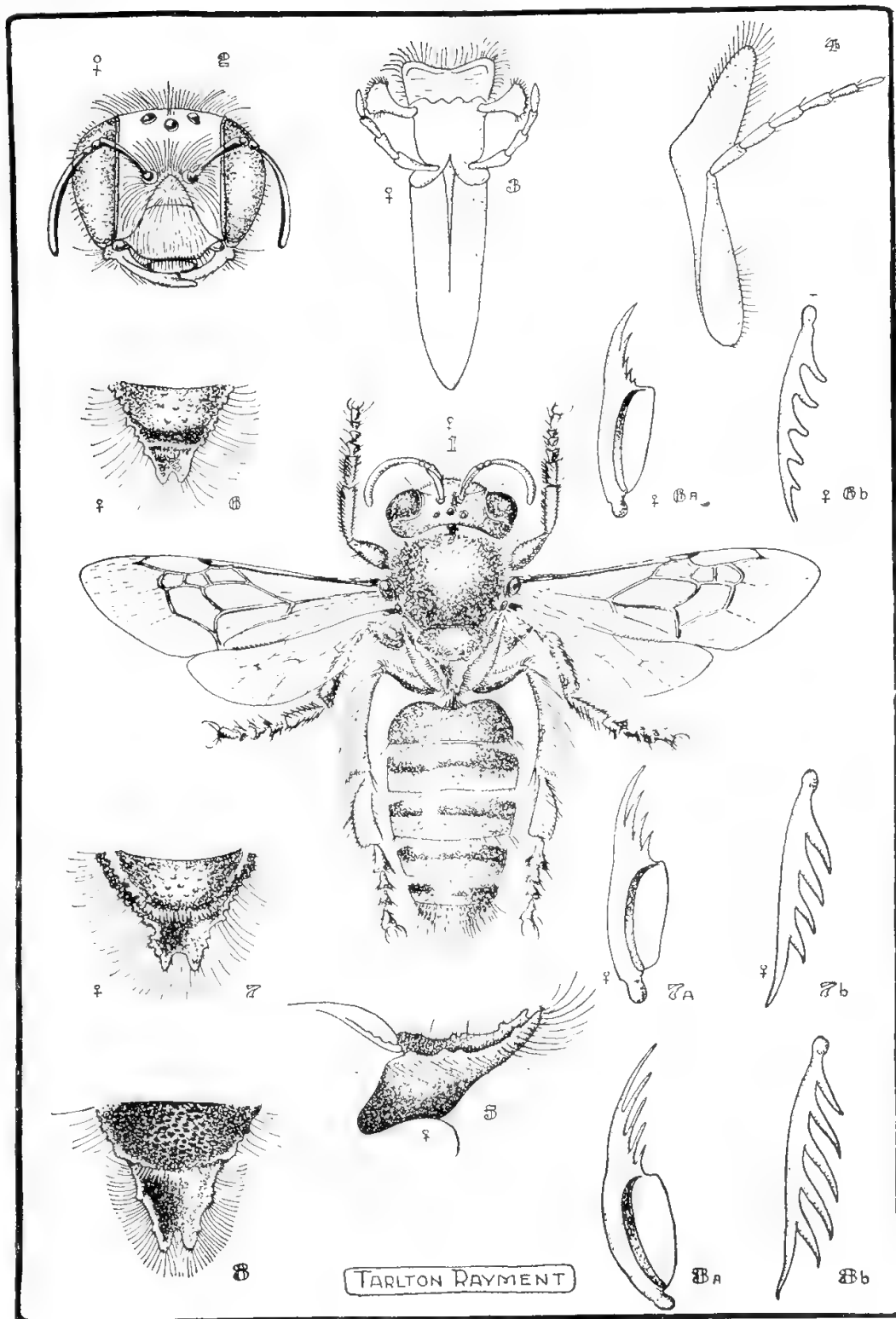
Plate XVIII.



EXPLANATION OF PLATE XIX.

1. Adult female of *Nodocolletes dentatus*, gen. et sp. nov.
2. Anterior view of head-capsule.
3. Glossa or tongue and labial palpi.
4. Maxillary palpi.
5. Lateral view of the scutellar process.
6. Scutellar process: 6a. Strigil; 6b. Hind calcar of *N. vigilans* (Sm.).
7. Scutellar process; 7a. Strigil; 7b. Hind calcar of *N. subentatus*, sp. nov.
8. Scutellar process; 8a. Strigil; 8b. Hind calcar of *N. dentatus*, sp. nov.

PLATE XIX.



EXPLANATION OF PLATE XX.

1. Adult male *Crocisa rufitarsus*, sp. nov.—legs not shown.
 2. Some of the scale-like hairs that form the patches—the four colours are pale blue, emerald green, light and dark purple.
 3. Adult female *Crocisa albifrons*, sp. nov.—legs not shown.
 4. Strigil of female.
 5. Pollen-granules from the fleece.
 6. Lateral and vertical view of the face-hairs.
 7. Front view of head-capsule of *Asaropoda punctata*, sp. nov.
 8. Strigil of the anterior leg.
 9. The sculpture of the mesothorax.
 10. Genitalia.
 11. Apical segment of the flagellum.
 12. Genitalia of *Asaropoda bombiformis* (Smith).
 13. The sculpture of the mesothorax.
 14. The sculpture of the mesothorax of *Asaropoda rufa*, sp. nov.
 15. Strigil of *Anthophora sordidula*, sp. nov.
 16. Genitalia of *Asaropoda albigena*, sp. nov.
 17. Neuration of the wing of *Anthoglossa vittata*, sp. nov.
 18. First and second segments of the flagellum.
 19. Strigil and hind calcar.
 20. Pollen-granules (*Eucalyptus*, sp.) from the leg of the female.
 21. Striate sculpture of face of *Halictus bremerensis*, sp. nov.
 22. Sculpture of the mesothorax.
 23. Anastomosing rugæ of the metathorax.
 24. Strigil of the female.
 25. Hind calcar of the female.
 - 26 and 27. Ventral and dorsal view of mites on this bee.
 28. Sculpture of the metathorax of *Halictus demissus*, Cockerell.
 29. Rugoso-punctate sculpture of the face.
 30. Anterior view of head-capsule of *Crocisa albifrons*, sp. nov.
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Plate XX.

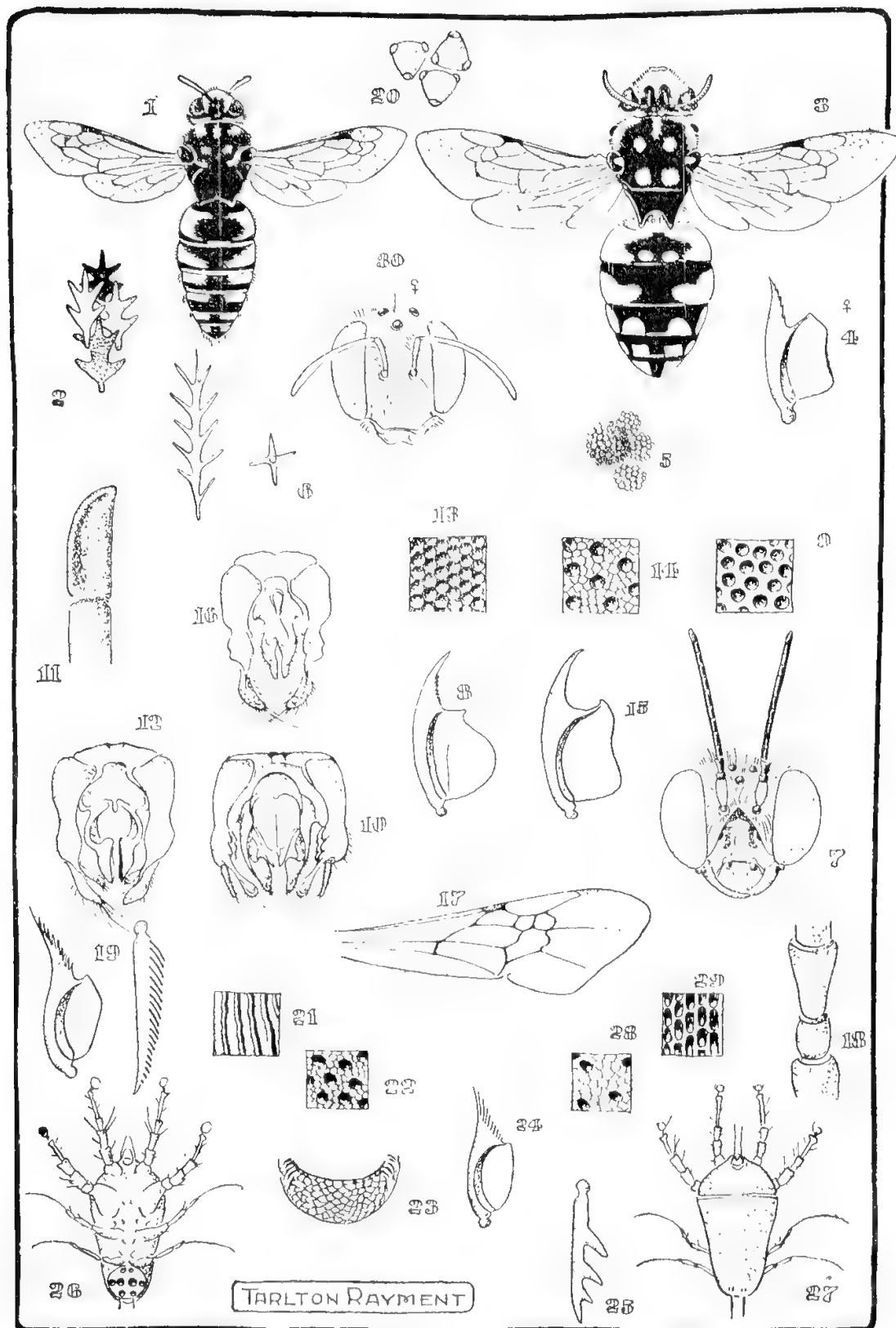
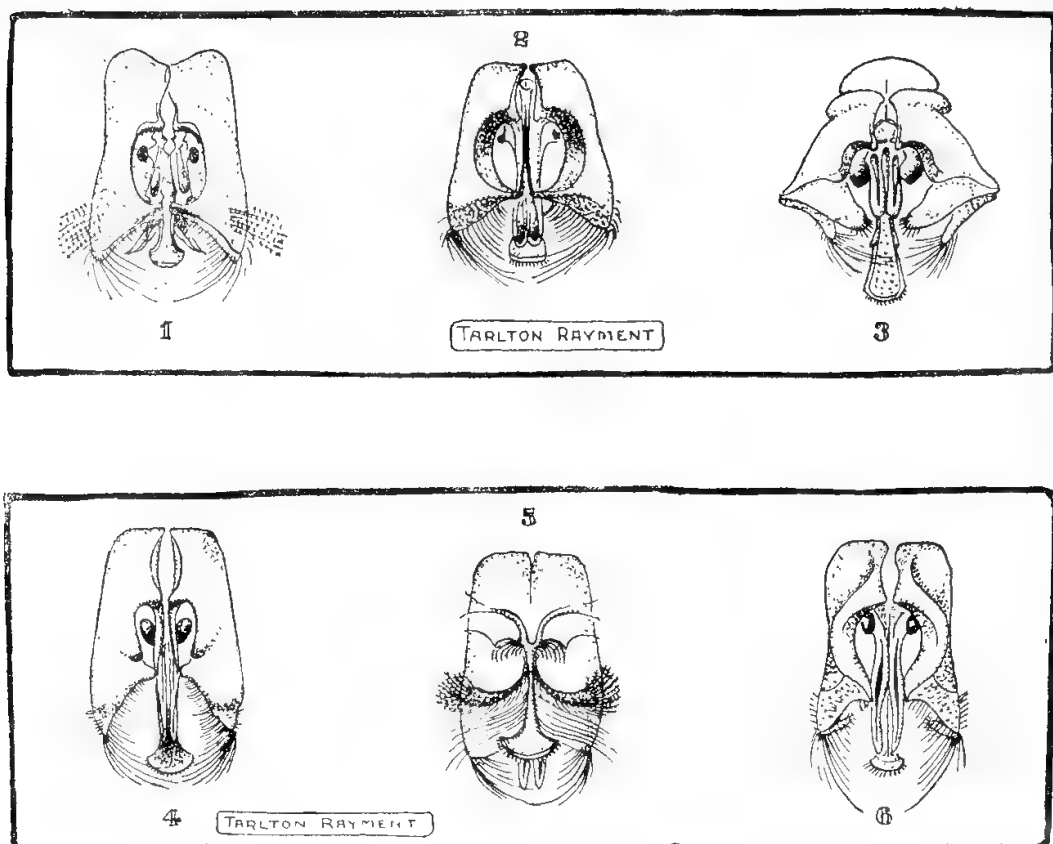


Plate XXI.



EXPLANATION OF FIGURES.

1. Genitalia of *Trichocolletes venustus* (Sm.).
2. Genitalia of *T. nigrochypcatus*, Raym.
3. Genitalia of *T. dowerinensis*, sp. nov.
4. Genitalia of *T. tenuiculus*, sp. nov.
5. Genitalia ventral view of *T. tenuiculus*, sp. nov.
6. Genitalia of *T. daviesiae*, sp. nov.

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